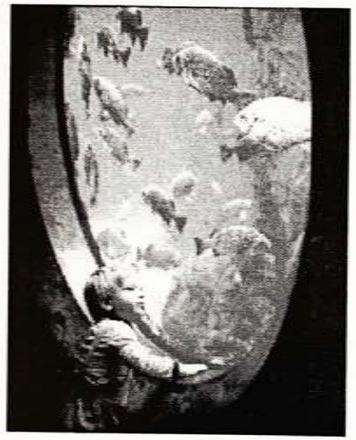
ARCHITECTURE DEPARTMENT **CHINESE UNIVERSITY OF HONG KONG**

MASTER OF ARCHITECTURE PROGRAMME 1996-97 DESIGN REPORT

UNDERWATER PEDESTRIAN HARBOUR CROSSING

LUI Yiu Wing Howard April 1997



UNDERWATER PEDESTRIAN HARBOUR CROSSING

Howard Lui

Thesis report

M.Arch II

May 1997

ACKNOWLEDGEMENTS

I wish to express my gratitude to all who have given support and assistance through the course of preparation of the report:

Mr. Alfred Yeung, Studio Instructor,
Department of Architecture, CUHK

Prof. Steve Lombardi, Programming Instructor,
Department of Architecture, CUHK

Mr. Chu Tai-Wen, Darwin, Second Tutor,
Department of Architecture, CUHK

I also greatly appreciate the assistance and information I received from the following persons and institutions:

Mr. Andrew Haper, Architect,
Anthony Ng Architects Ltd.

Miss Betty Chan, P. R. Manager,
MTR Co. Ltd.

Mr. Lawenance Mak, Graduate Architect,
Kwan & Assoicates Ltd.

Mr. Richard Garrett, Project Manager,
Maunsell-Acer-Parsons Brinkerhoff JV

Mr. Richard Wong,
Lawson T & Sung Surveyors

Mr. Richard Yu, Town Planner,
Nomometric Design and Planning Consultants

Mr. Sam Mcbride, Architect,
MTR Co. Ltd.

Mr. Tai Yu Fu,
Citybus Ltd.

Kumagai Gumi Co.Ltd.

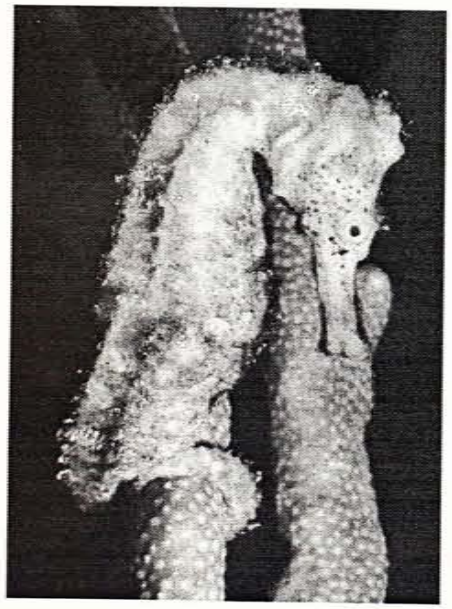
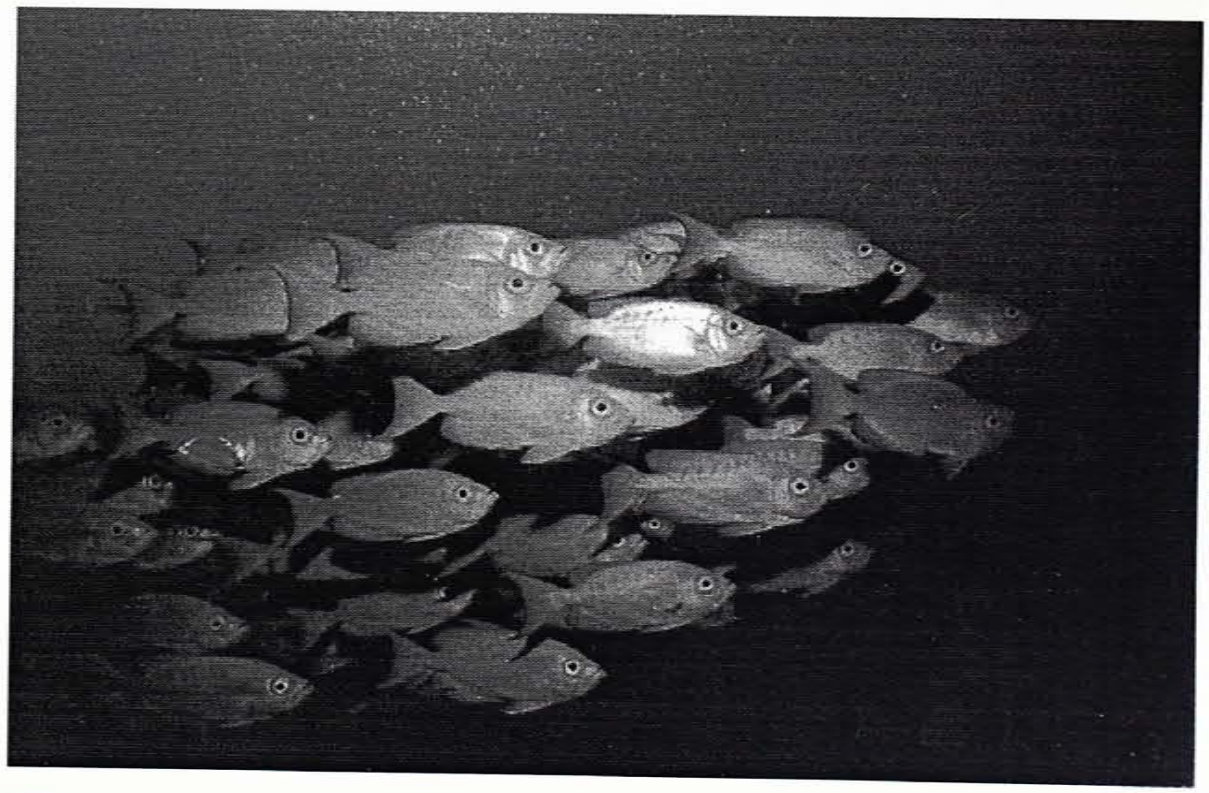
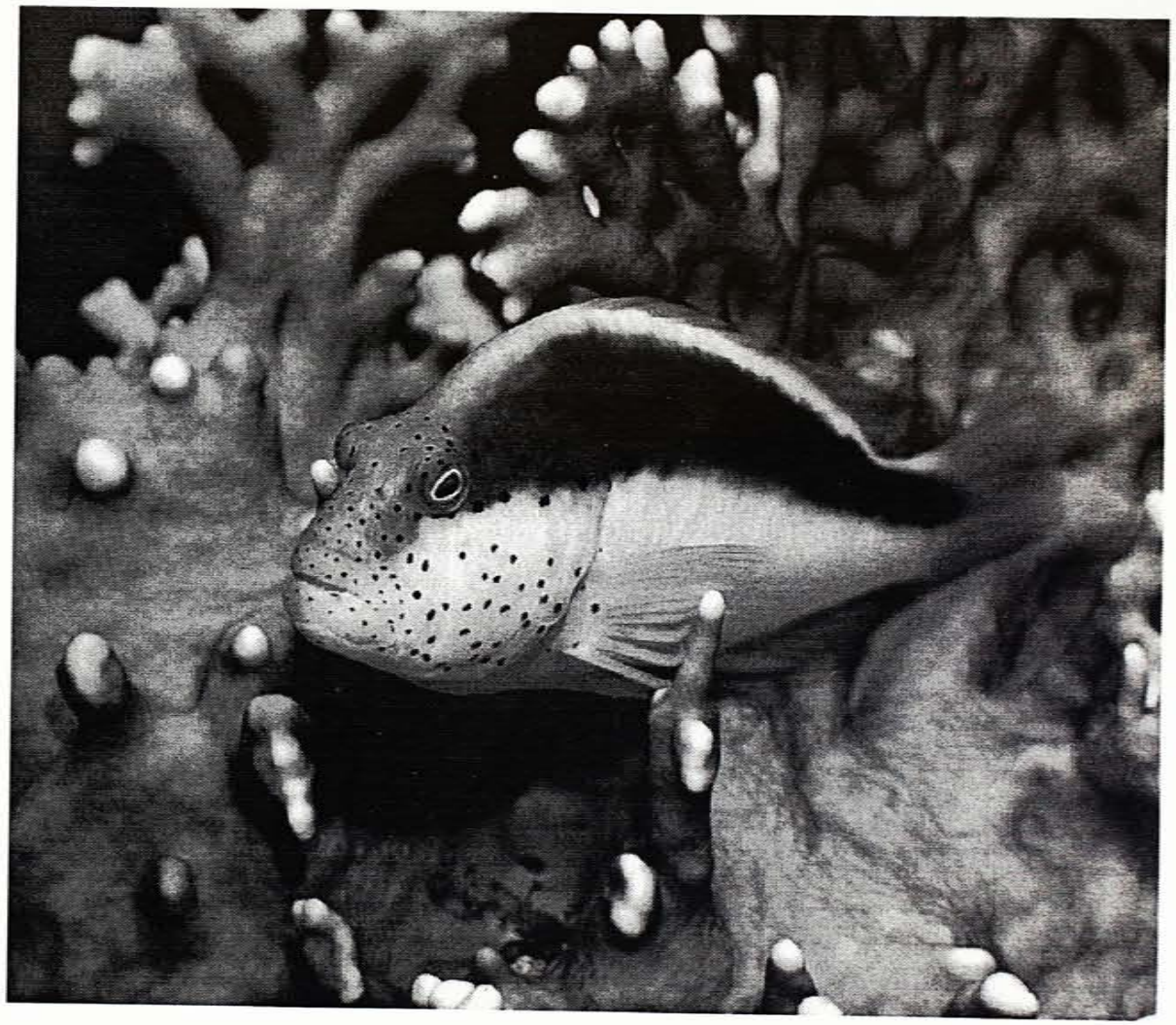


TABLE OF CONTENTS



CHAPTER 1 INTRODUCTION



1.1 BACKGROUND

1.1.1 Victoroia Harbour

The present of the Victoria Harbour divides Hong Kong into two pieces of lands, which is Kowloon condition and Hong Kong Island condition.

The Victoria Harbour is one of the best deep water port in the world. In the last decade, by the benefit of the harbour, Hong Kong has developed from a small fish village to an international metropolis with one of the best container port in the world.

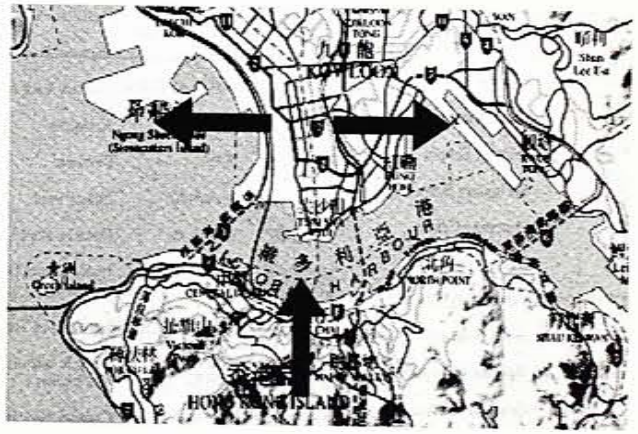
Along the harbour front, urbanization is rapidly grown and high-rise buildings are extruded everywhere. The harbour front, as a result, is one of the most beautiful scenery in the world. The tourist industry is now the highest income to the Hong Kong economy.

Panoramic view of HK after dark

1.1.2 Development strategy

The hilly geographical nature of Hong Kong give constraints to the urban development. The solutions are land reclamation and mountain cut. Furthermore, the present of the Victoria Harbour limits the choice of reclamation strategy.

In order to keep adequate width to the harbour, land reclamation is being restricted. In Kowloon side, the land reclamation is towards east-west pattern whilst in Hong Kong Island is toward the north. This situation directly control the urban development and the location of the Central Business District (CBD).



Land reclamation strategy

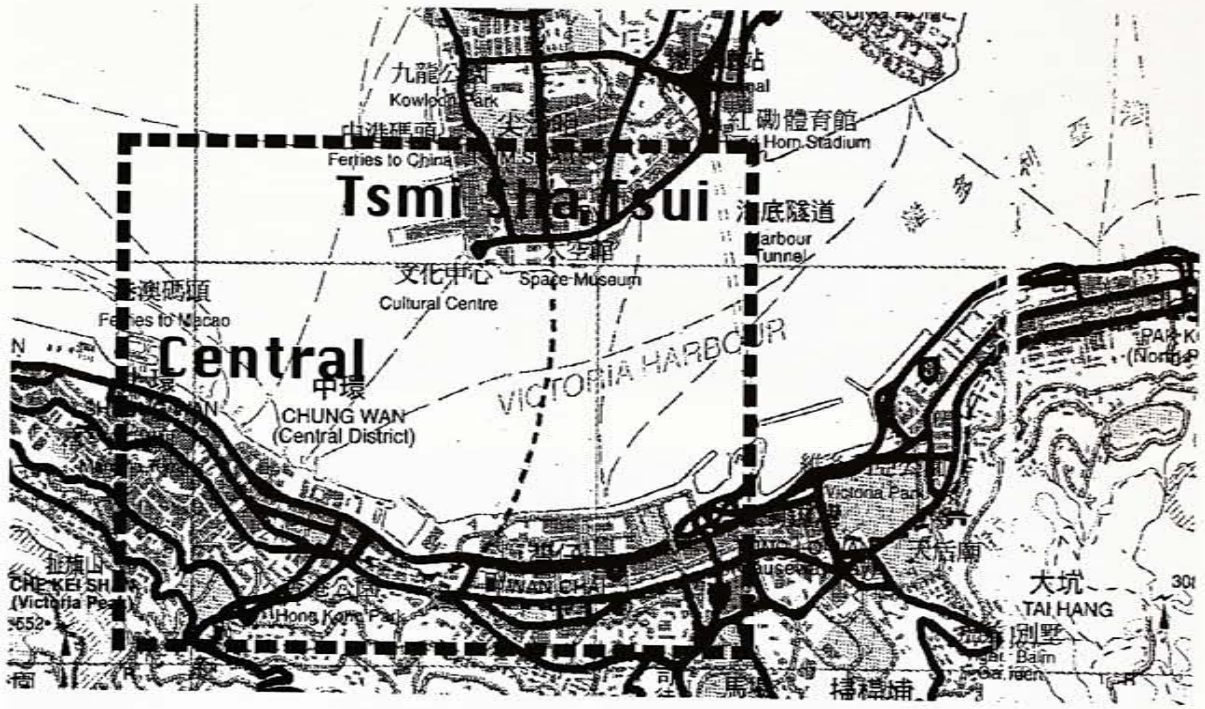
1.1.3 Central Business District

The CBD in Hong Kong is located in two places: Tsim Sha Tsui and Central. The harbour width between these two districts is the smallest distance compare to other part of the Victoria Harbour.

In Tsim Sha Tsui, high-rise office towers, hotels, shopping malls and major institutional facilities are located within the district. The majority of the tourists are settle down here. International well-known retails and sightseeing scenic not only attract tourists but local citizens also like to visit this district. The waterfront along Tsim Sha Tsui south is the best place to enjoy the beautiful scenery of Hong Kong Island and the skyline of The Peak.

Central, the heart of Hong Kong Economy, is the highly urbanized district. High-rise office towers together with international company headquarters are found everywhere. The Central Reclamation Project will extend the CBD core from Charter Road to a linear development sectors divided by future roads system. Famous buildings like HK Bank, Legislative Council let Central become the landmark of Hong Kong.

Due to the physical geographical land form characteristics, the urban fabric in Hong Kong Island is in linear pattern which all urban area is along the Victoria Harbour. Districts near CBD like Admiralty, Wan Chai and Causeway Bay play part of the role of CBD. These districts also have well-develop network connect to Tsim Sha Tsui in different transportation means.



CBD Location

1.1.4 Cross Harbour Traffic

As the present of the Victoria Harbour separate the urban districts physically, the two sides can only connect by different transportation systems. The cross harbour traffic between Kowloon and Hong Kong Island is taking in two forms: by sea and by land.

	Private	Public
By sea		HK Ferry Star Ferry
By land	Private car Motor-cycle	MTR Bus Minibus Taxi

Table showing different ways to cross the harbour

According to The Annual Traffic Census 1991, the total daily cross harbour passengers was about 1,400,000. 56% by MTR, 30% by bus, 13% by ferry.

	Total passengers	%
MTR	784,000	56%
Bus	420,000	30%
Ferry	182,000	18%
Total	1,400,000	100%

Table showing average daily crossing harbour passengers statistic, 1991[1]

The cross harbour traffic in land is taken in the form of cross harbour tunnel. Now, there are total five cross harbour tunnels in Hong Kong. They are:

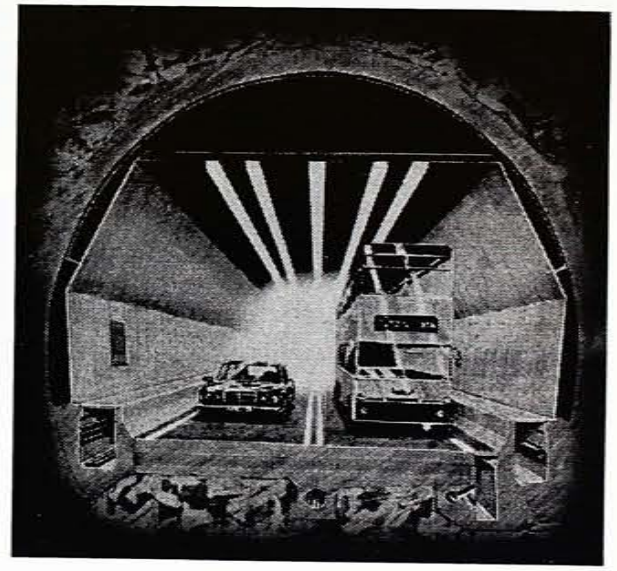
1. Cross Harbour Tunnel
2. Cross Harbour Tunnel for MTR
3. Eastern Cross Harbour Tunnel
4. Western Harbour Crossing
5. Western Harbour Crossing for Airport Rail

(4 & 5 are under construction now)

[1]*The annual traffic census 1991- Transport dept.*

Star Ferry

MTR



The Cross Harbour Tunnel

The existing cross harbour tunnel

1. Western Harbour Crossing
2. Western Harbour Crossing for airport rail
3. Cross Harbour Tunnel for MTR
4. Cross Harbour Tunnel
5. Western Cross Harbour Tunnel

1.2 ISSUES & POTENTIAL

1.2.1 Issues

The present situation of the Victoria Harbour physically separate the urban area into two pieces. These urban areas can only be connected by transport system and create heavy loading and pressure of all sorts of traffic.

The existing Cross Harbour Tunnel between TST and Causeway Bay is over-saturated and cause traffic jam everyday. Within the district, it is impossible to built another tunnel to share this overcrowded traffic load. It causes a lot of problems in the existing CBD and the same situation will happen to the future reclamation site.

Although the government built the Eastern Harbour Crossing and the Western Harbour Crossing, the two tunnels are far from the CBD. They only can share regional traffic load and cannot solve the problem between TST and Central.

The existing Central Reclamation Project is narrowing down the width of the Victoria Harbour. However, the ship traffic load is still increased especially lot of ships have inter-crossing in different directions and is very dangerous to the harbour traffic. It is impossible to use ferry to share the traffic congestion on land.

Is it possible to do something in between the Victoria Harbour?

1.2.2 Potential

Along the two waterfronts of the harbour are the most busy commercial and cultural areas in Hong Kong, it will has high commercial value if a new 'development' can be taken place so as to connect the two waterfronts. If this 'development' can physically create another network for people across the harbour, this 'development' itself will have high commercial value, especially retails trade.

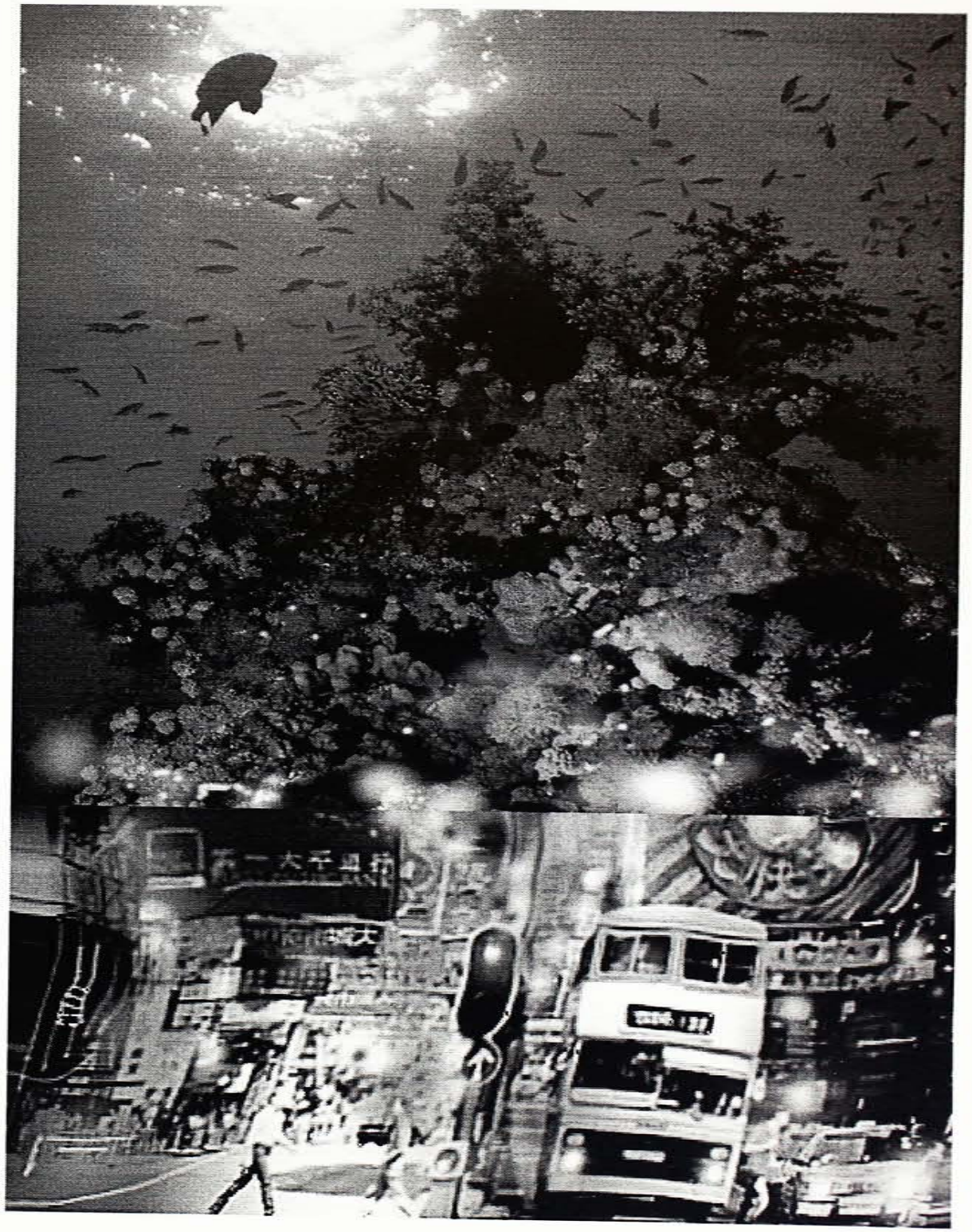
Also, the existing Central Reclamation Project shorten the length of the Victoria Harbour, the shortest distance is about 840M. It is not a long distance for pedestrian passing through. Also, this short distance is not difficult for building something in between. (The Eastern Harbour Crossing has almost 1.8 Km.)

1.3 OBJECTIVES

Objectives

Connect the CBD areas of Kowloon side and Hong Kong Island side physically in order to create a high commercial quality development.

Provide another linkage for people to cross the harbour. This new linkage hopefully can share the overcrowded traffic load the two waterfront CBD.



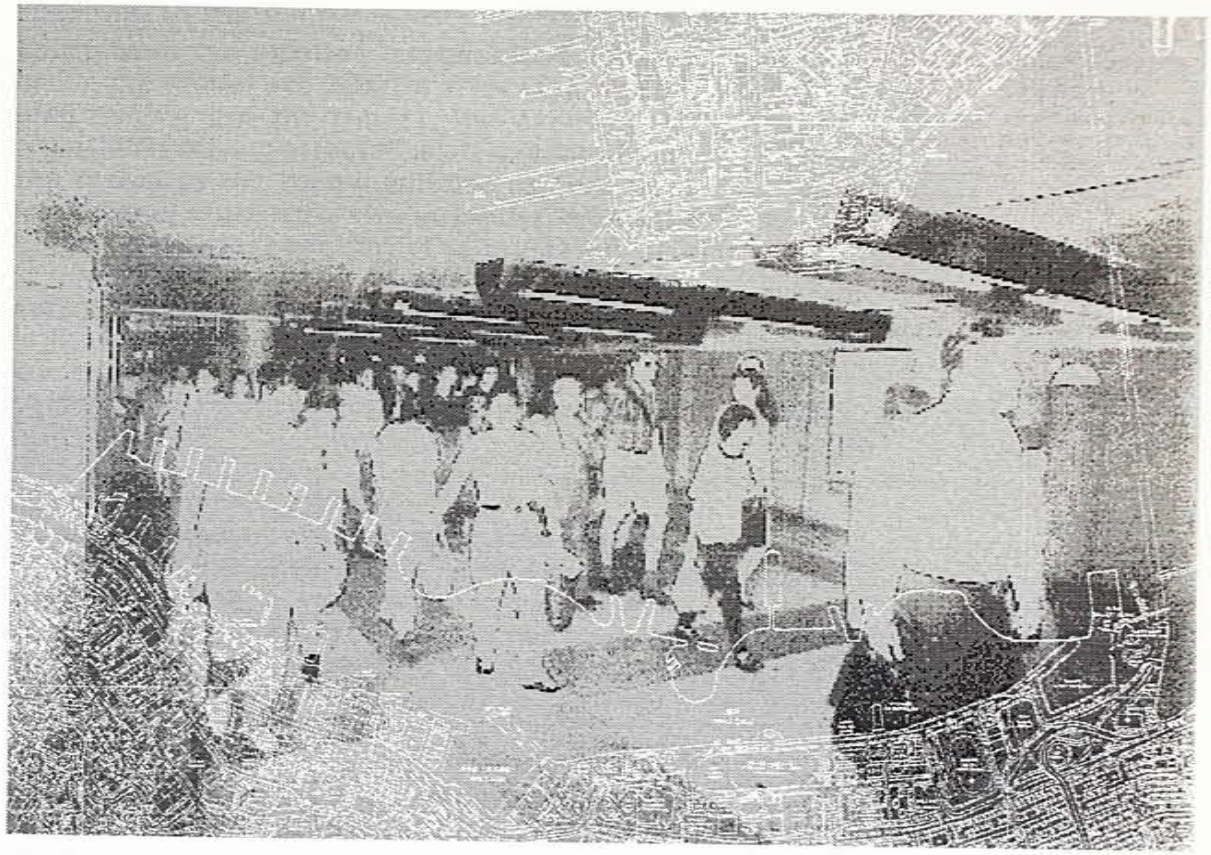
1.4 CONCEPT

Concept

UNDERWATER PEDESTRIAN HARBOUR CROSSING

Up to now, the method of crossing the Victoria Harbour is to construct an underwater tunnel so as to link the two waterfronts. All the existing cross harbour tunnels are only for vehicles and MTR. To fulfilled the objectives stated in the last section, it is impossible to build another underwater tunnel for vehicular because the transport interchange around the entrances need occupy lot of land and the land in the existing CBD is extremely expensive.

As the objective of the cross harbour traffic is to bring people from one side to another, it is possible to build an underwater walkway for pedestrian. This walkway can provide another choice for cross harbour traffic and lower the existing traffic load. Besides, there is no need to occupy a lot of land for building interchange facilities around the two tunnel entrances. Furthermore, as this tunnel is a pedestrian walkway for lot of people passing through the harbour, the commercial value around the two entrances and throughout the walkway will be very high. Also, this will be the first underwater pedestrian tunnel and the unique underwater spatial feeling together with other facilities will not only attract local people but also a lot of tourist will visit the tunnel during their trips.



Underwater Pedestrian Harbour Crossing

1.5 DEVELOPMENT PROCESS

Development process

Background
Describe the existing situation, that is the present of the Victoria Harbour physically restricts the development strategy and directly affects the location of CBD. As a result, cross harbour traffic becomes important to link up the two waterfronts. On the other hands, the existing traffic congestion of cross harbour traffic raise up lot of issues.

Issues and potential
Describe the issues, that are the existing traffic conjestion and the separation of CBD; on the other hands to highlight the underlining development potential which is caused by those issues.

Objectives
To set up the objectives base on the development potential and try to overcome the issues. The objectives are to be developed a new linkage so as to connect the two separated CBD with high commercial value; and to solve the regional traffic conjestion.

Concept
To link up Kowlon and HK Island by an underwater pedestrian walkway.

Narrow down the scope of topic and define the problem statement by selection of site
First of all, the problem statement is formed by starting from the site selection. By selecting different connecting points of the tunnel to narrow down the scope of issues. Final site selection are at TST in Kowloon side; Central and Causeway Bay in HK Island side. As a result, 4 or 5 tunnel routes are being selected and have a brief site analysis among each route. The final decision will be based on client's point of views to select the final route of the pedestrian walkway.

Functions of the tunnel
Apart from the existing issues, what happens inside the tunnel will directly affect the reasons why people use the tunnel. The existing site situation is mainly affected what happens inside the tunnel as the tunnel will link up two sites. (that's why start from site analysis) Define the users' group, searching the existing site activities are the most important steps in this part. Besides, analysing the image of underwater will help to give guidelines for creating the uniqued spatial feeling. The findings of the above sections will form the framework of the building functions.

Research and case studies
By doing different research and field works so as to give evidences and data to support the previous chapters. Besides, by using the real-life case studies both in Hong kong and overseas to learn how other people to deal with similar problems.

Brief formulation
Base on the above findings and try to set up the assumptions, client profiles, missions and form the project brief.

Design program
Base on the above findings and the project brief to set up the design program, individual components, schedule of accommodation and their inter-relationship.

Technology research
As it is a project related to underwater development. The technology research will focus on how to use water to integate into different building systems and services like lighting, air-conditioning, structure and so on.

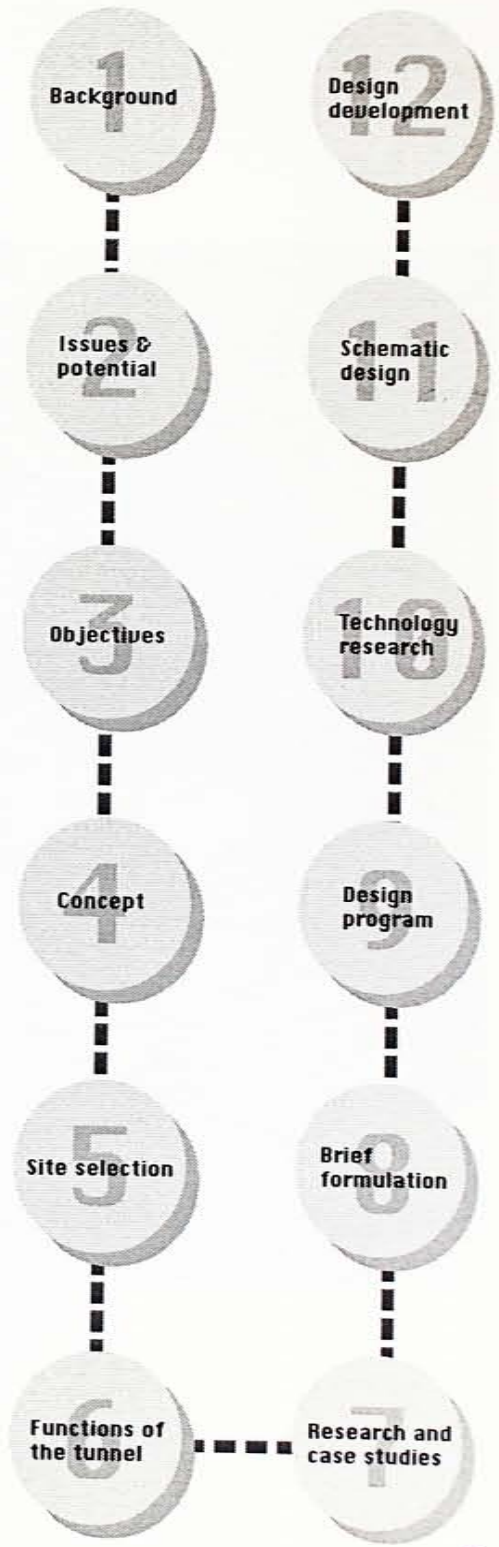
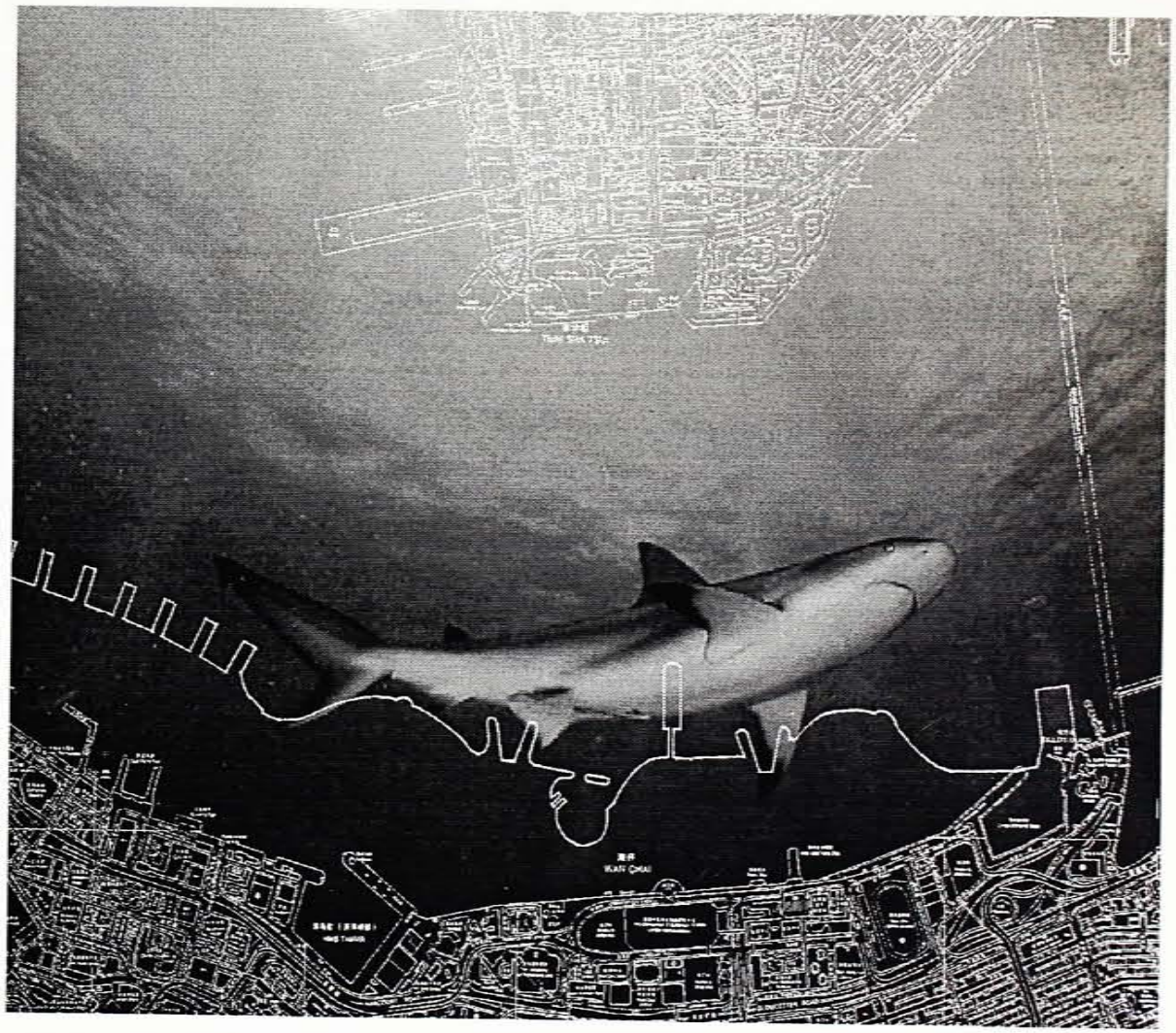


Diagram showing development process

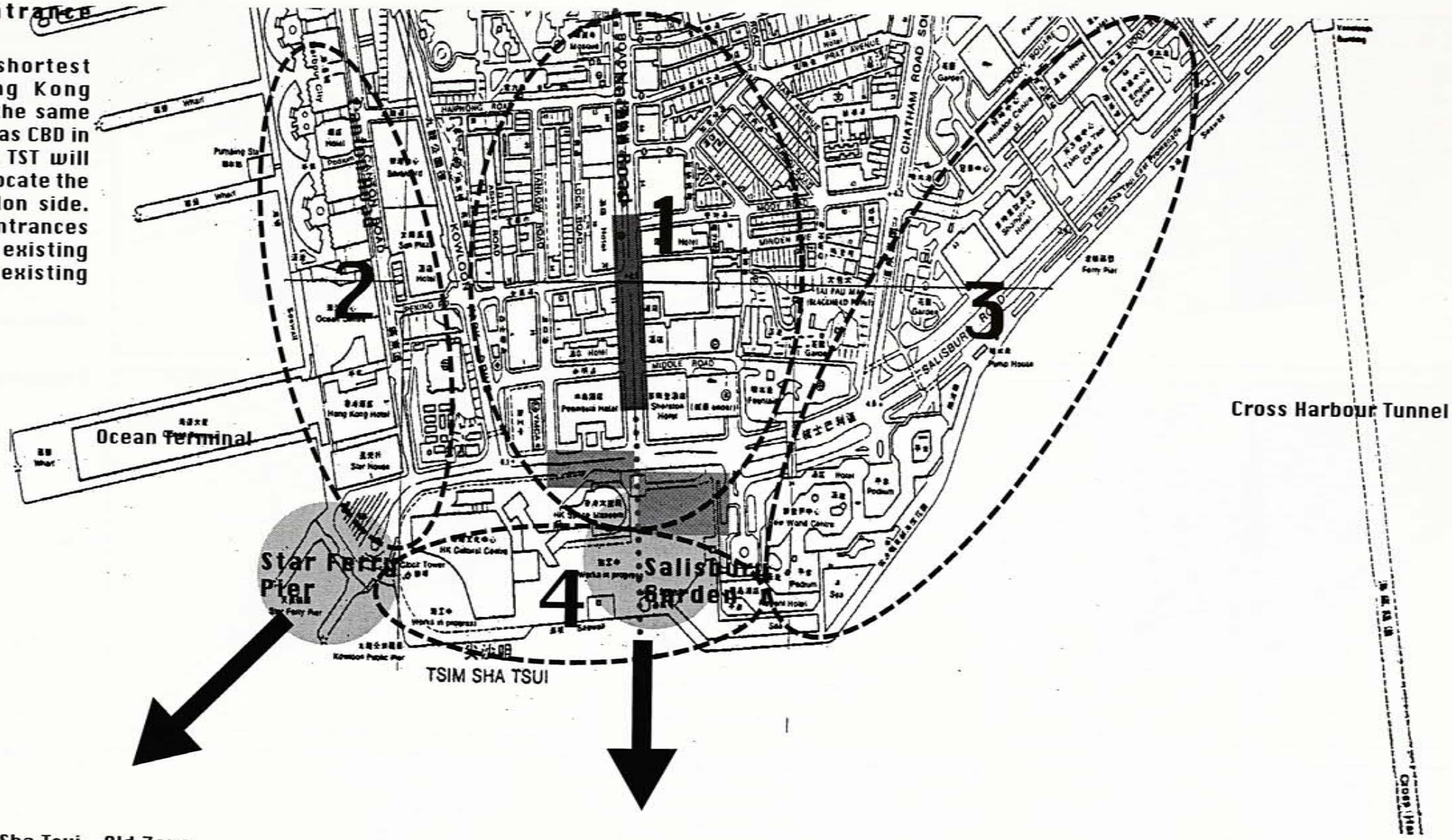
CHAPTER 2 SITE SELECTION



2.1 KOWLOON SIDE

Proposed tunnel entrance location

Tsim Sha Tsui has the shortest distance between Hong Kong Island. Besides, it plays the same role as Central and serve as CBD in Hong Kong. As a result, TST will become the best place to locate the tunnel entrance at Kowlon side. Two options of tunnel entrances are found. They are the existing Star Ferry Pier and the existing Salisbury Garden.



Zoning pattern of Tsim Sha Tsui

Old Zone

1. Along Nathan Road and extend towards the harbour front is the old zone of TST. Mix-used, mid-rise buildings are found in this zone. Most of the buildings in this zone have more than 15 years old. Around this area, retail shops can be found at the ground level and form shopping street. Nathan Road is one of the famous shopping street in Hong Kong.

New Zone

2 & 3. The areas along the waterfront are the new zone of Tsim Sha Tsui. Along the east and west waterfront consists modern office buildings and hotels. Their podiums are connected by link bridges.

4. Along the south waterfront, a group of cultural and institutional complex are located there with open pedestrian walkway.

Key

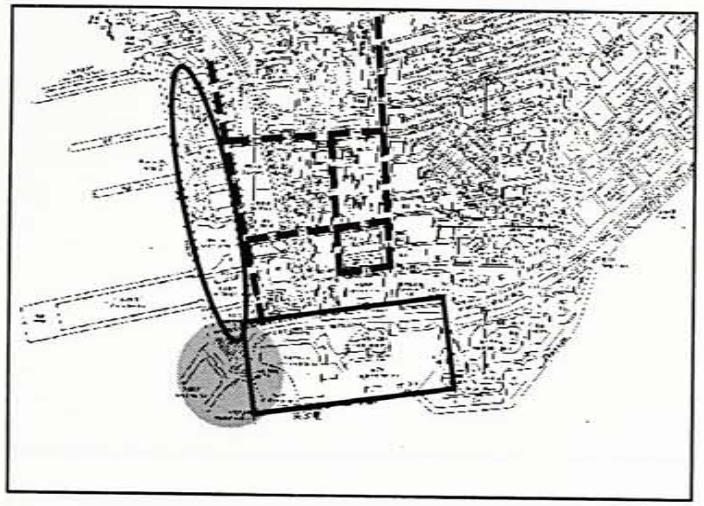
- Proposed tunnel entrance
- Existing underground development
- Proposed tunnel route

2.2 PROPOSED ENTRANCE AT TST

Star Ferry Pier, TST

2.2.1 Surrounding context

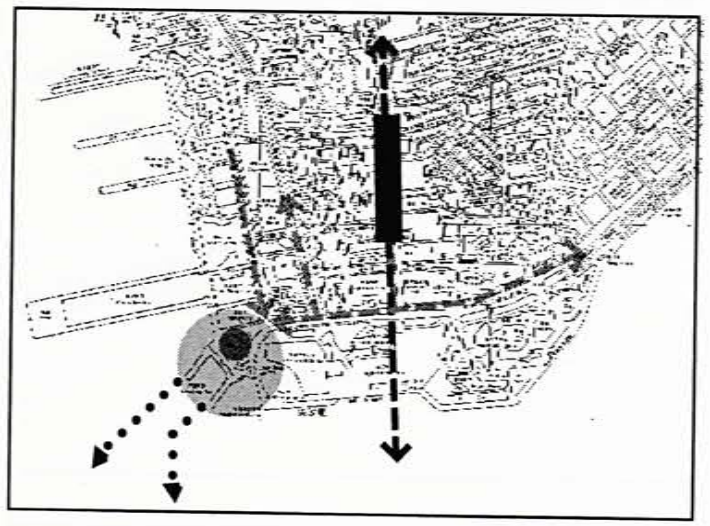
The site is located at the junction between Canton Road and Salisbury Road. Along Canton Road, series of shopping malls are found. Besides, high-class retails are located at the street level along Canton Road. On the other hand, cultural complex are located along Salisbury Road.



Key

- Proposed tunnel entrance
- Shopping street
- Shopping mall
- Cultural and institutional complex

2.2.2 Surrounding transport networks



Key

- Proposed tunnel entrance
- MTR station
- MTR route
- Bus terminal
- Major traffic route
- Ferry route

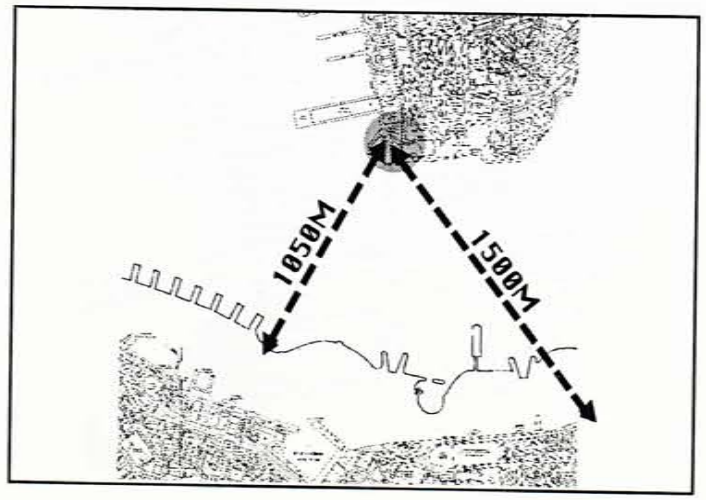
2.2.3 Distance between Hong Kong Island

Star Ferry Pier to Central Basin (Central Reclamation Project Phase I & II):

1050M

Star Ferry Pier to Causeway Bay (Existing cargo handling basin):

1500M



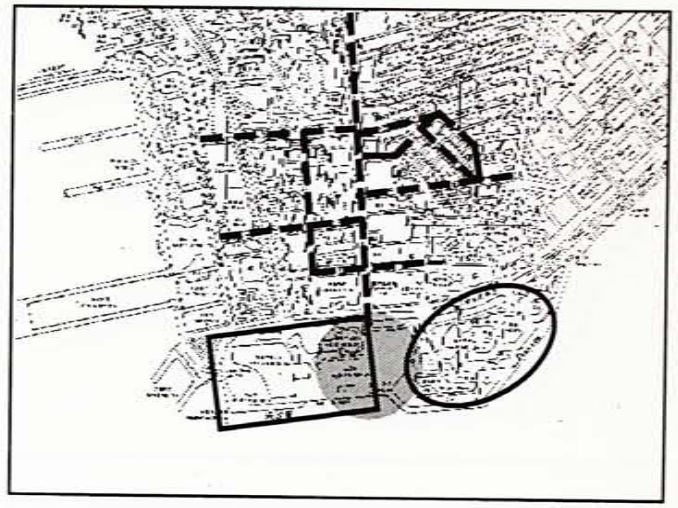
Key

- Proposed tunnel entrance

Salisbury Garden, TST

2.2.1 Surrounding context

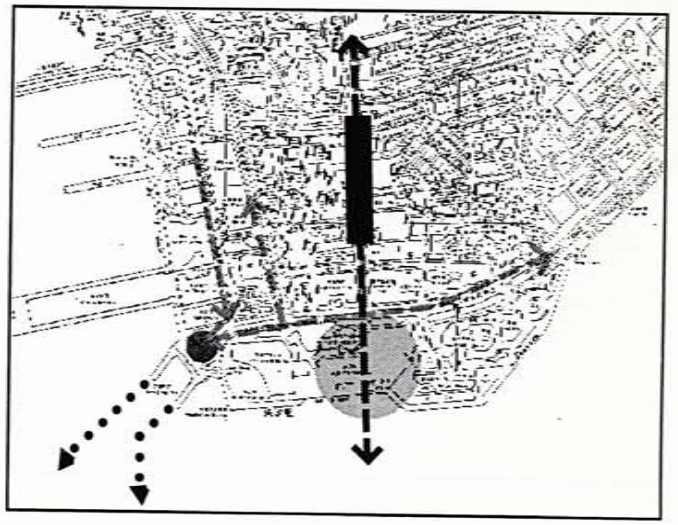
The site is located at the existing Salisbury Garden. Multi-levels shopping mall and carpark are located underneath the site. Besides, the existing MTR route is passed through the site at underground level.



Key

- Proposed tunnel entrance
- Shopping street
- Shopping mall
- Cultural and institutional complex

2.2.2 Surrounding transport networks



Key

- Proposed tunnel entrance
- MTR station
- MTR route
- Bus terminal
- Major traffic route
- Ferry route

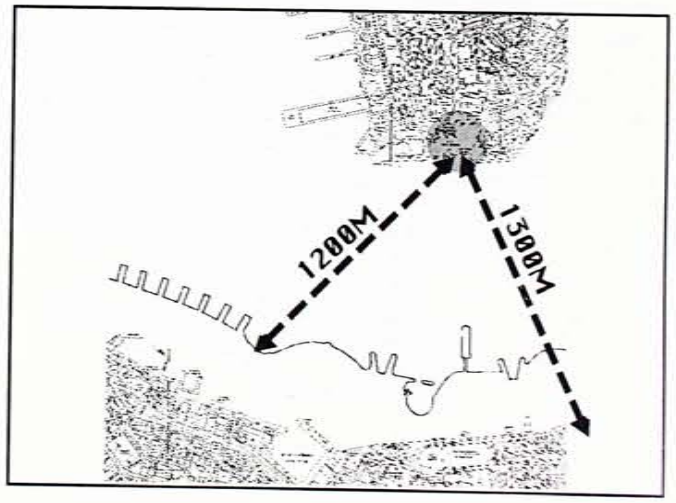
2.2.3 Distance between Hong Kong Island

Salisbury Garden to Central Basin(Central Reclamation Project Phase I & II):

1200M

Salisbury Garden to Causeway Bay (Existing cargo handling basin):

1300M



Key

- Proposed tunnel entrance

2.2.4 Pedestrian fluidity

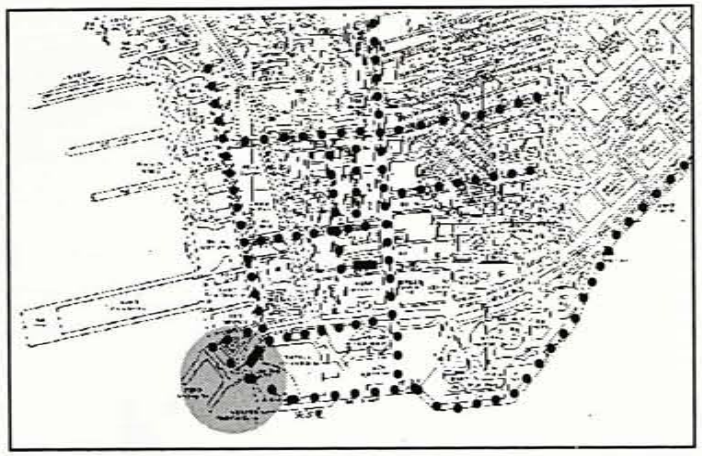
Pedestrian fluidity at street level

Key

Proposed tunnel entrance

Street level pedestrian flow

Star Ferry Pier, TST

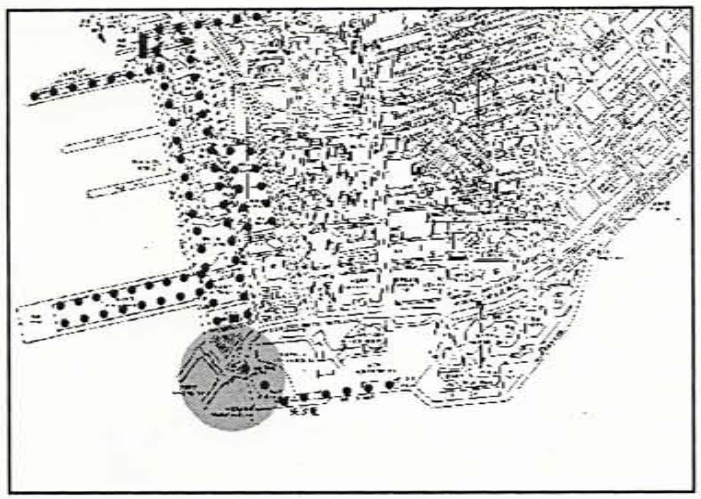


Pedestrian fluidity at podium level

Key

Proposed tunnel entrance

Podium level pedestrian flow



Future pedestrian flow (with the proposed tunnel)

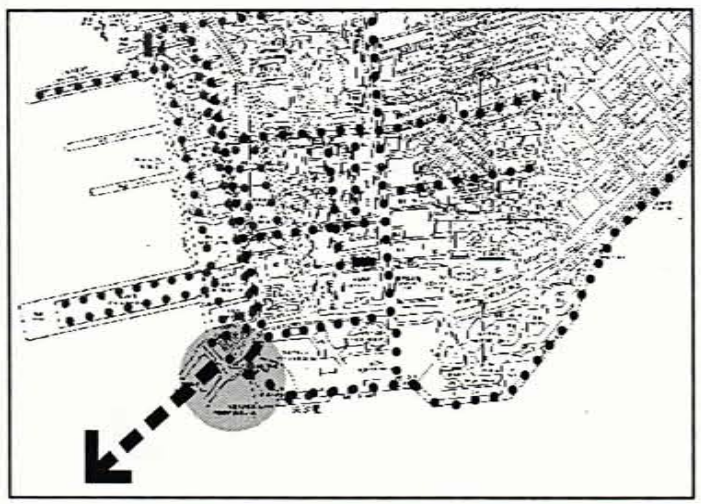
Key

Proposed tunnel entrance

Street level pedestrian flow

Podium level pedestrian flow

Underwater level pedestrian flow



2.2.4 Pedestrian fluidity

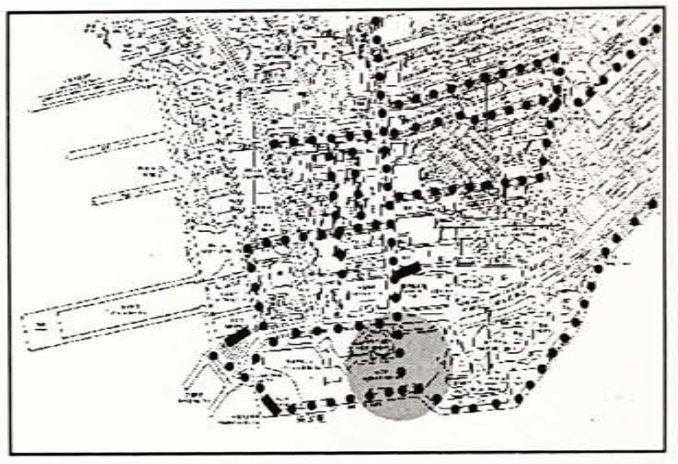
Pedestrian fluidity at street level

Key

Proposed tunnel entrance

Street level pedestrian flow

Salisbury Garden, TST

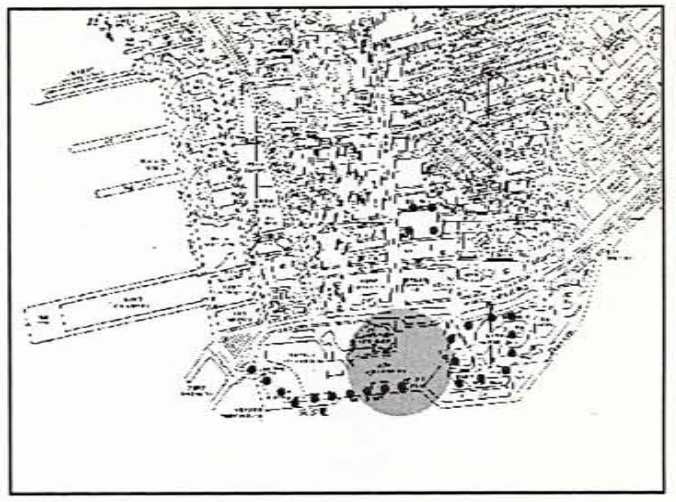


Pedestrian fluidity at podium level

Key

Proposed tunnel entrance

Podium level pedestrian flow



Future pedestrian flow (with the proposed tunnel)

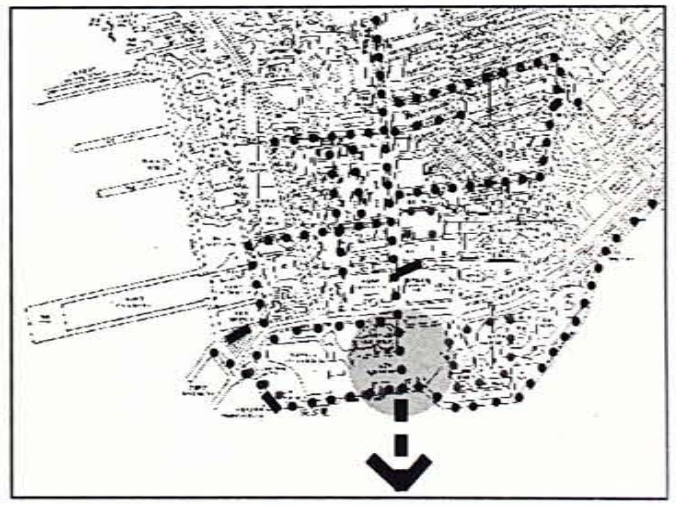
Key

Proposed tunnel entrance

Street level pedestrian flow

Podium level pedestrian flow

Underwater level pedestrian flow



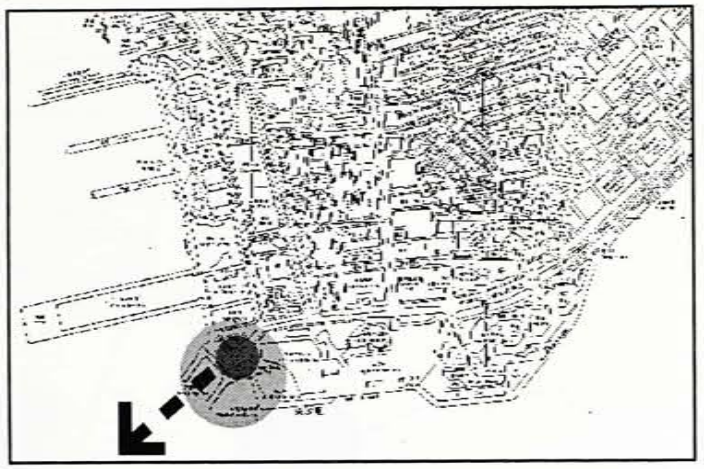
2.2.5 Potential Development

2.2.5.1 The existing Star Ferry Pier, bus terminal, and the Clock Tower Plaza will be redeveloped to form the entrance of the pedestrian tunnel.

Key

- Proposed tunnel entrance
- Potential redevelopment area
- Proposed tunnel

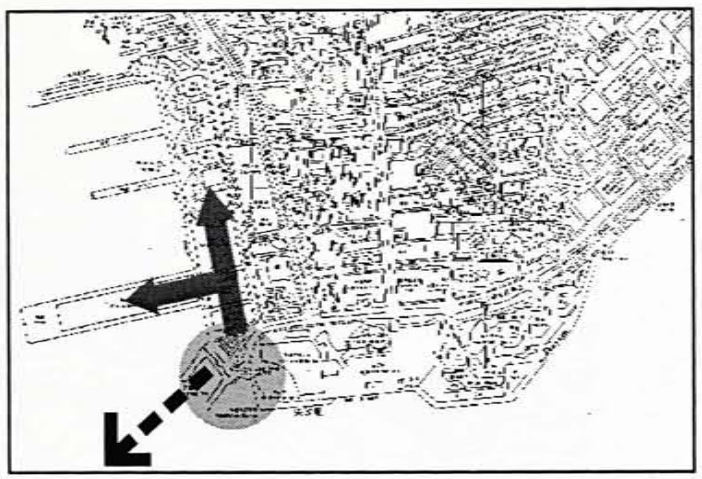
Star Ferry Pier, TST



2.2.5.2 The proposed tunnel entrance can link up the existing Ocean Terminal.

Key

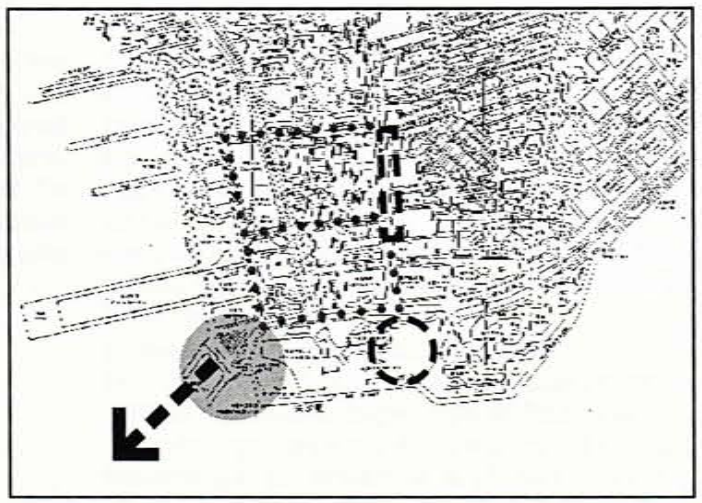
- Proposed tunnel entrance
- Potential connection to other developments nearby
- Proposed tunnel



2.2.5.3 The proposed tunnel entrance can link up the existing MTR station and underground development by series of underground networks.

Key

- Proposed tunnel entrance
- Potential underground network
- MTR station
- Existing Underground development
- Proposed tunnel



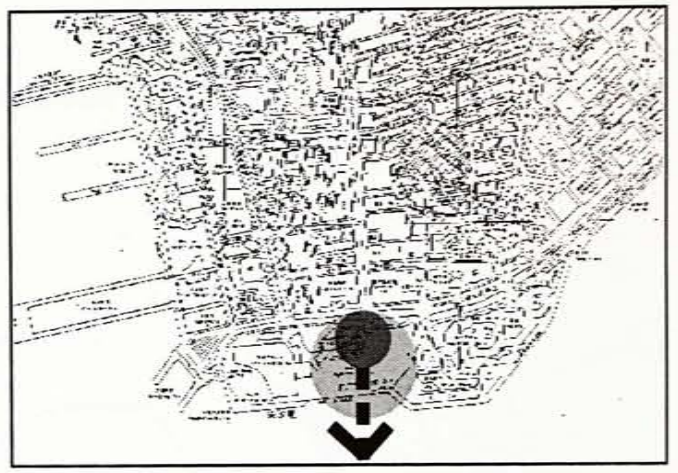
2.2.5 Potential development

2.2.5.1 The existing Salisbury Garden will be redeveloped and form the entrance of the pedestrian tunnel.

Key

- Proposed tunnel entrance
- Potential redevelopment area
- Proposed tunnel

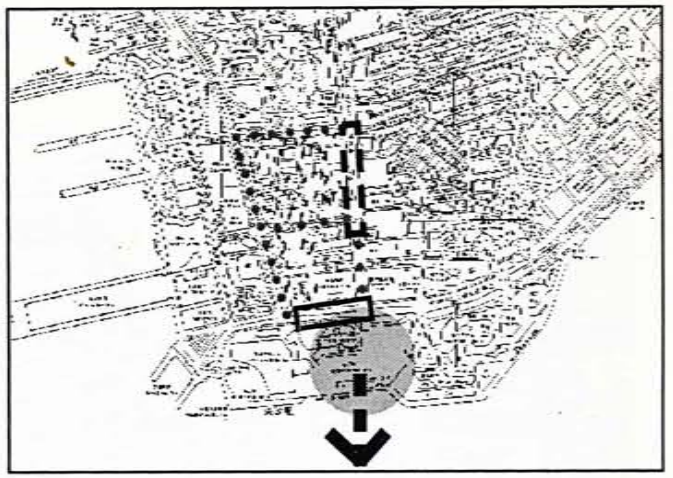
Salisbury Garden, TST



2.2.5.2 The proposed tunnel entrance can link up the existing MTR station and underground development by series of underground networks.

Key

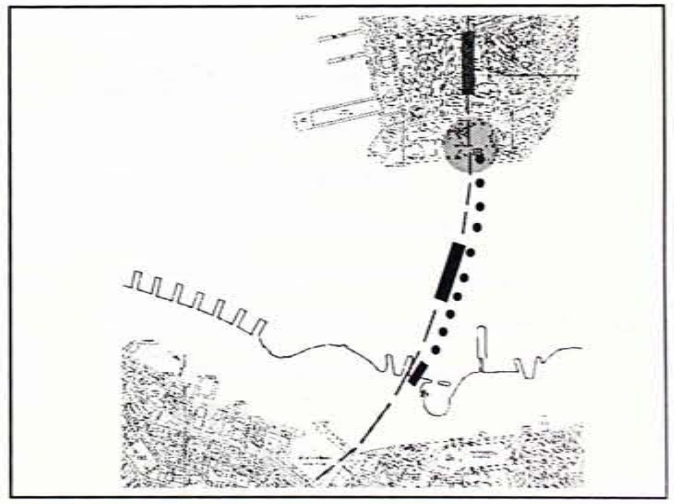
- Proposed tunnel entrance
- Potential underground network
- MTR station
- Existing underground development
- Proposed tunnel



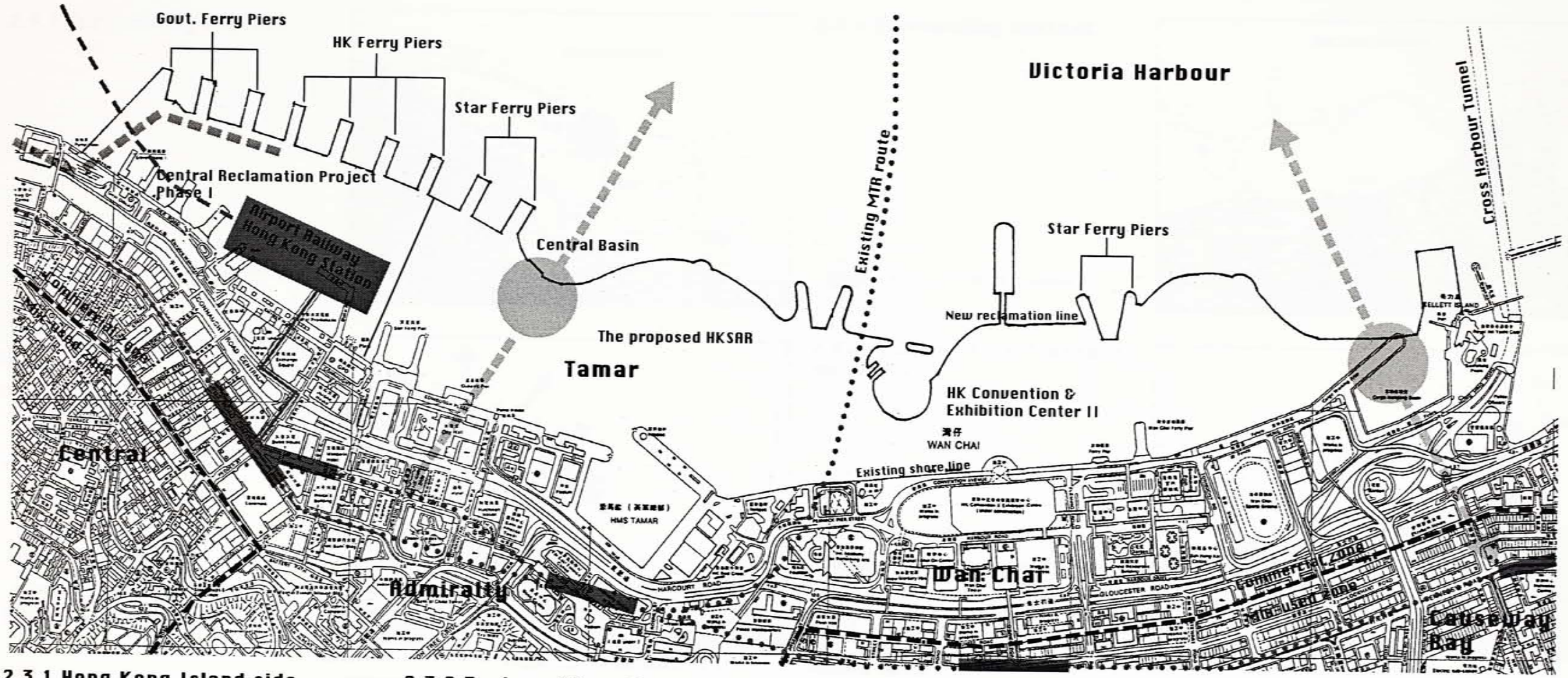
2.2.5.3 The proposed underwater pedestrian tunnel can build next to the existing MTR route. A new station can be located in the middle of the harbour to connect the two tunnels.

Key

- Proposed tunnel entrance
- Proposed MTR station
- Existing MTR station
- Existing MTR route
- Proposed pedestrian tunnel



2.3 HONG KONG ISLAND SIDE



2.3.1 Hong Kong Island side

After the four phases of Central-Wan Chai Reclamation Project are completed, the shoreline of HongKong Island will extend towards Kowloon side. The urban fabric will also follow the new shoreline to expand. The proposed pedestrian tunnel will connect to the new reclamation site and extend to the existing CBD.

2.3.2 Zoning of Hong Kong Island

The hilly geographical nature directly form a linear development pattern in Hong Kong Island. This linear urban fabric is created by series of land reclamation projects. Each reclamation project forms a new zone of urban area. By analysing the existing situation, we can divide two zones to the existing urban fabric. These two zones are:

1. *Highly commercialized zone*

This zone is located along the waterfront. Within the zone, high-rise office towers, hotels, government and institution buildings in modern outlook can be founded everywhere. Flyovers are used to connect the building podiums.

2. *Mix-used zone*

This zone is paralleled to the commercial zone and stop at the lower part of the mountain. Within this zone, both residential buildings and commercial buildings are found. Most of these buildings have more then 20 years history.

2.3.3 Location of tunnel entrance

The proposed pedestrian tunnel will locate at the new reclamation land and connect to the existing urban center. Two sites are selected: Central Basin and Causeway Bay.

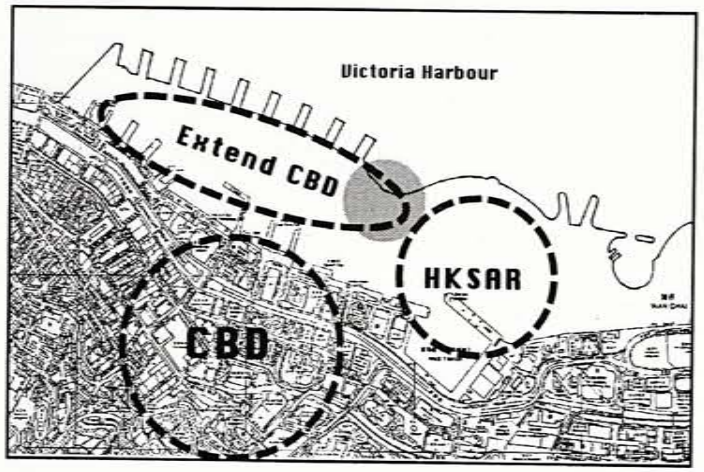
Key

- Existing MTR Station
- Existing MTR route
- Zoning boundary
- Future Airport Rail route
- New underground walkway
- Proposed tunnel entrance and the route
- Highways interchange

2.4 PROPOSED ENTRANCE AT HK ISLAND

Central Basin

2.4.1 Surrounding context



Key

Proposed tunnel entrance

2.4.2 Surrounding transport networks

Key

Proposed tunnel entrance

Existing MTR station & route

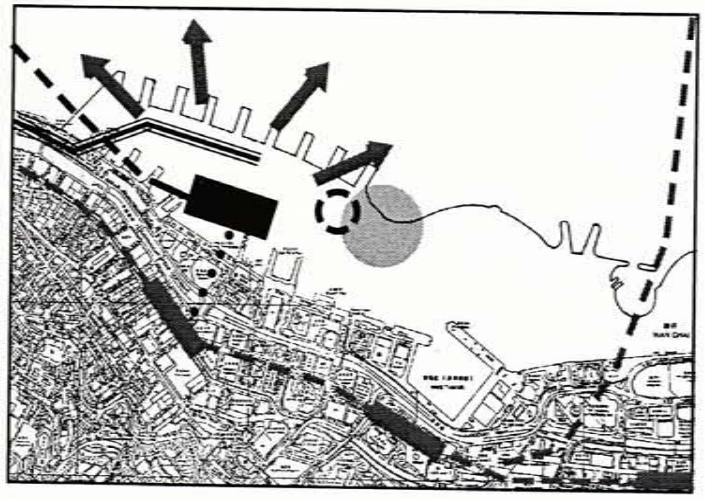
Underground walkway

Future bus terminal

Highway

Ferry pier and routes

Airport rail & HK Station



2.4.3 Distance between TST

Central Basin (Central Reclamation Project Phase I & II) to Star Ferry Pier:

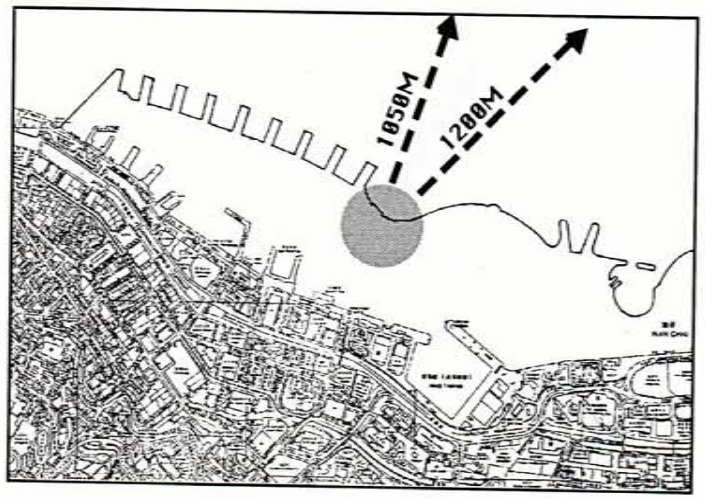
1050M

Central Basin (Central Reclamation Phase I & II) to Salisbury Road:

1200M

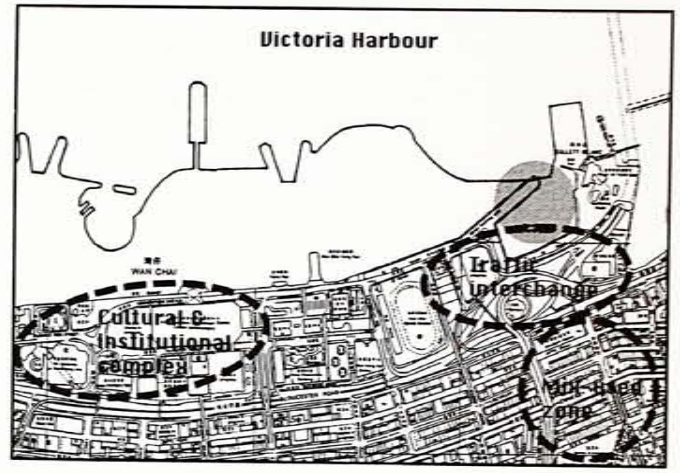
Key

Proposed tunnel entrance



Causeway Bay

2.4.1 Surrounding context



Key

Proposed tunnel entrance

2.4.2 Surrounding transport networks

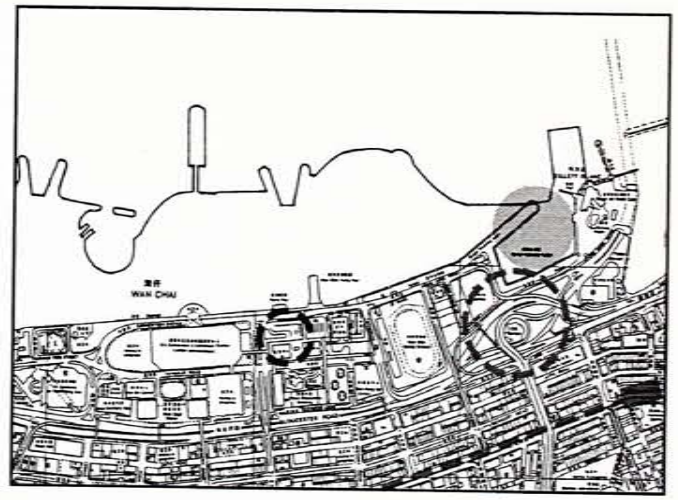
Key

Proposed tunnel entrance

Existing MTR station and route

Bus terminal

Transport interchange



2.4.3 Distance between TST

Causeway Bay to the Star Ferry Pier:

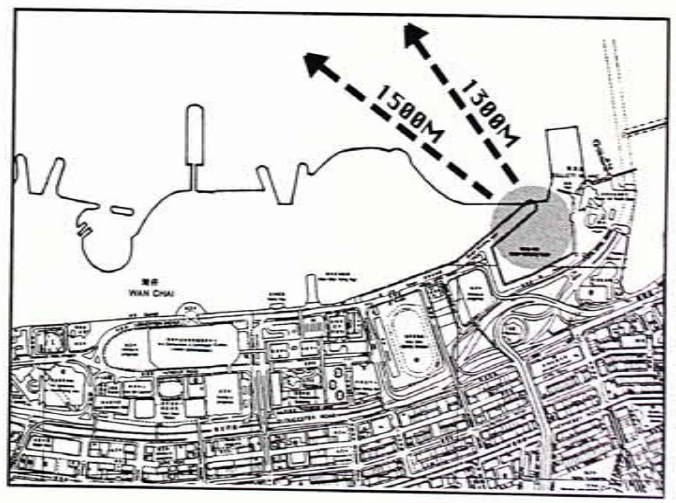
1500M

Causeway Bay (Existing cargo handling basin)to Salibury Garden:

1300M

Key

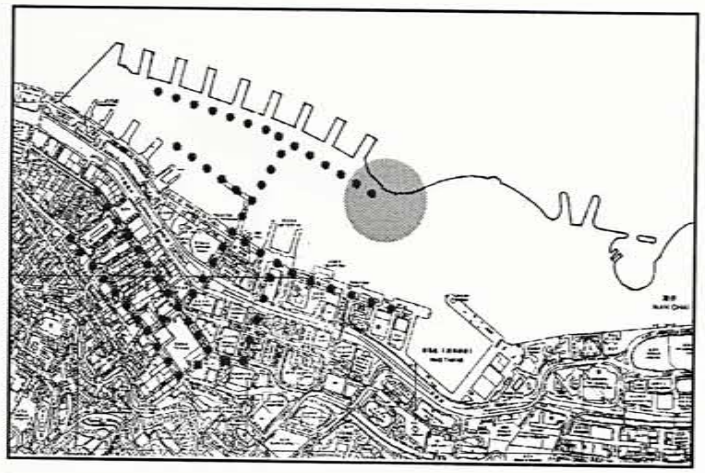
Proposed tunnel entrance



2.4.4 Pedestrian fluidity

Central Basin

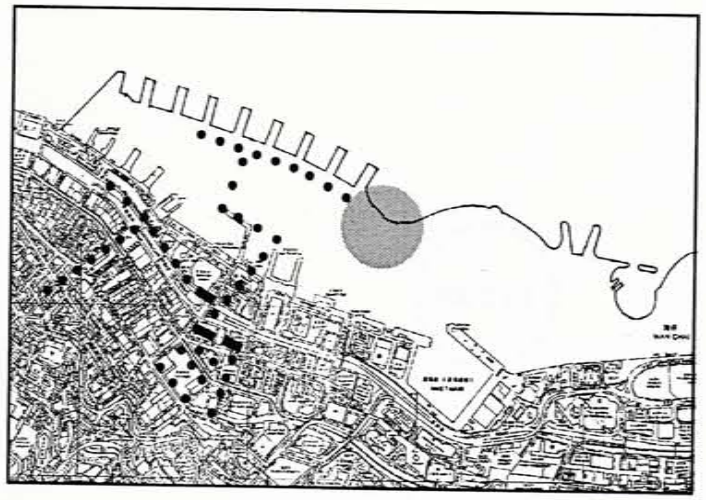
Pedestrian fluidity at street level



Key

- Proposed tunnel entrance
- Street level pedestrian flow

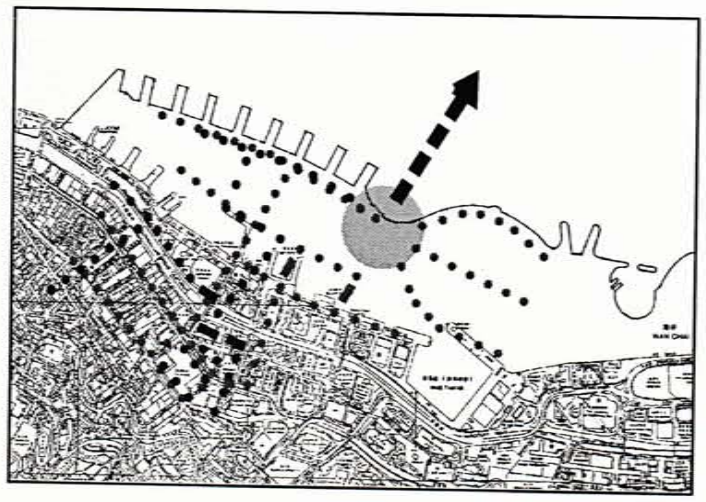
Pedestrian fluidity at podium level



Key

- Proposed tunnel entrance
- Podium level pedestrian flow

Future pedestrian flow (with the proposed tunnel)



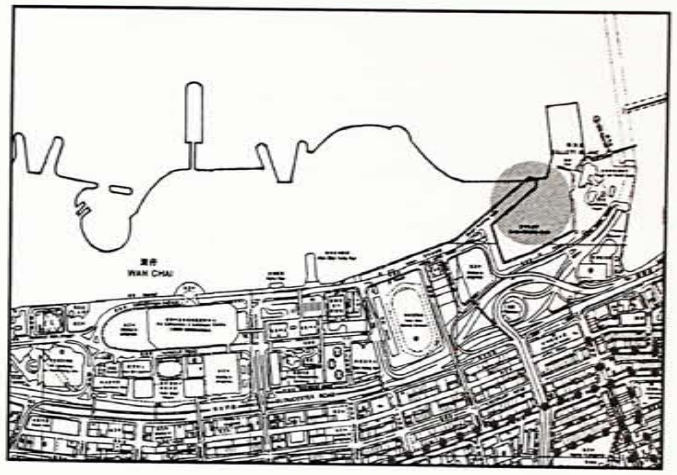
Key

- Proposed tunnel entrance
- Street level pedestrian flow
- Podium level pedestrian flow
- Underwater level pedestrian flow

2.4.4 Pedestrian fluidity

Causeway Bay

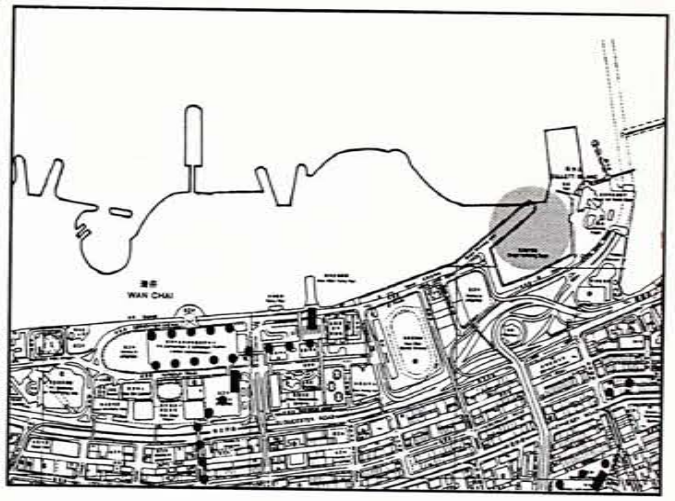
Pedestrian fluidity at street level



Key

- Proposed tunnel entrance
- Street level pedestrian flow

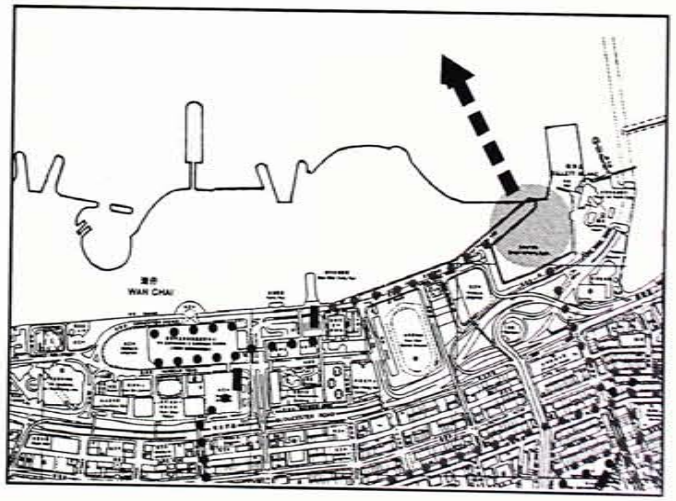
Pedestrian fluidity at podium level



Key

- Proposed tunnel entrance
- Podium level pedestrian flow

Future pedestrian flow (with the proposed tunnel)



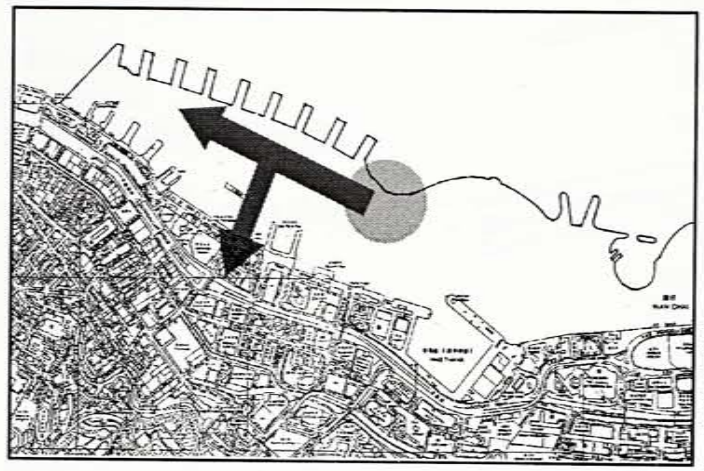
Key

- Proposed tunnel entrance
- Street level pedestrian flow
- Podium level pedestrian flow
- Underwater level pedestrian flow

2.4.5 Potential development

Central Basin

2.4.5.1 The future pedestrian tunnel has potential to link up the HK Ferry Pier Complex and the Airport Rail Hong Kong Station. As a result, passengers from the Ferry Pier and HK Station can directly through the tunnel to go to Kowloon.

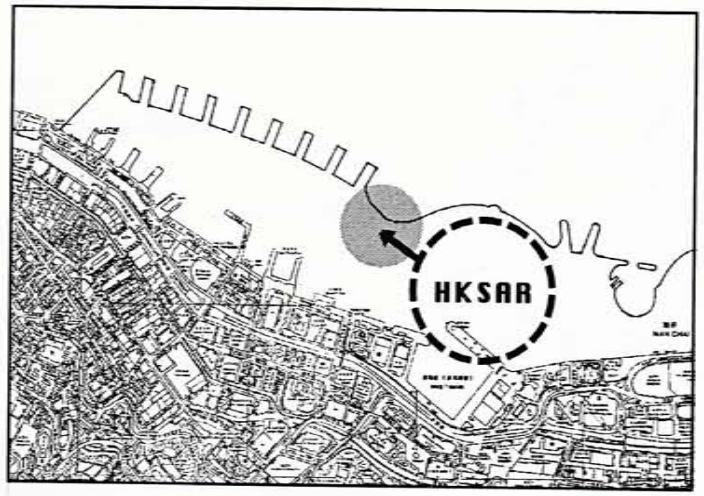


Key

Proposed tunnel entrance

Potential linkage

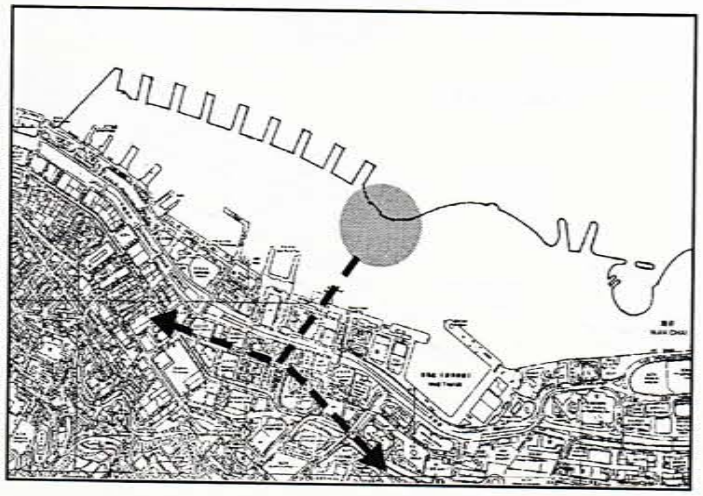
2.4.5.2 The proposed HKSAR will locate at Tamar, just next to the pedestrian tunnel entrance. The proposed tunnel can directly connect to the HKSAR either at ground level or at underground level.



Key

Proposed tunnel entrance

2.4.5.3 The proposed pedestrian tunnel can further connect to the existing CBD by underground networks.



Key

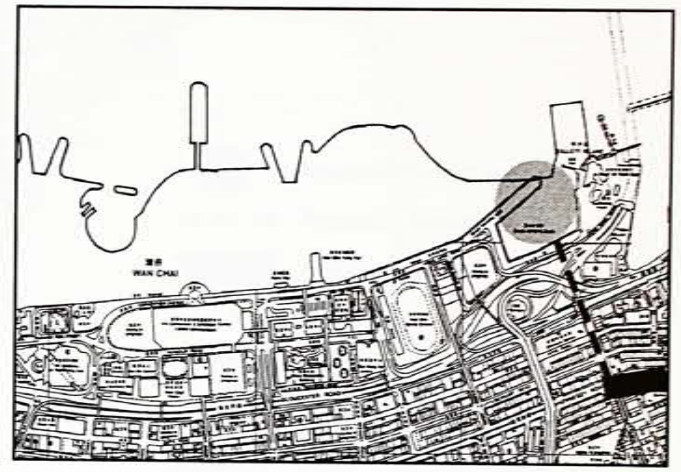
Proposed tunnel entrance

Potential linkage

2.4.5 Potential development

Causeway Bay

2.4.5.1 The proposed pedestrian tunnel can directly link to the existing Causeway Bay MTR station so as to attract more people to use the tunnel.



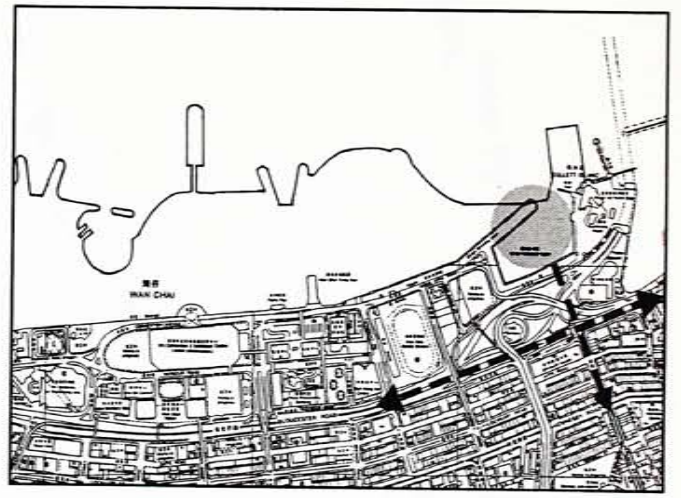
Key

Proposed tunnel entrance

Potential linkage

Existing MTR station

2.4.5.2 The proposed pedestrian tunnel can further link to the existing shoreline, that is along Gloucester Road so as to increase the development potential at that region.

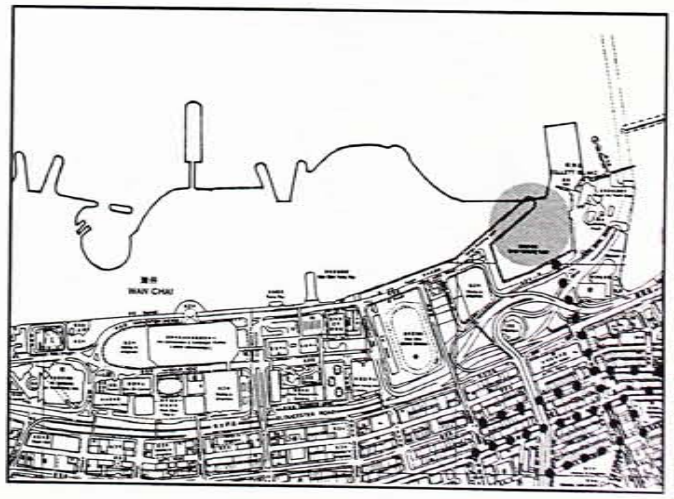


Key

Proposed tunnel entrance

Potential linkage

2.4.5.3 The proposed pedestrian tunnel can connect to the existing shopping streets at ground level in the center of Causeway Bay.



Key

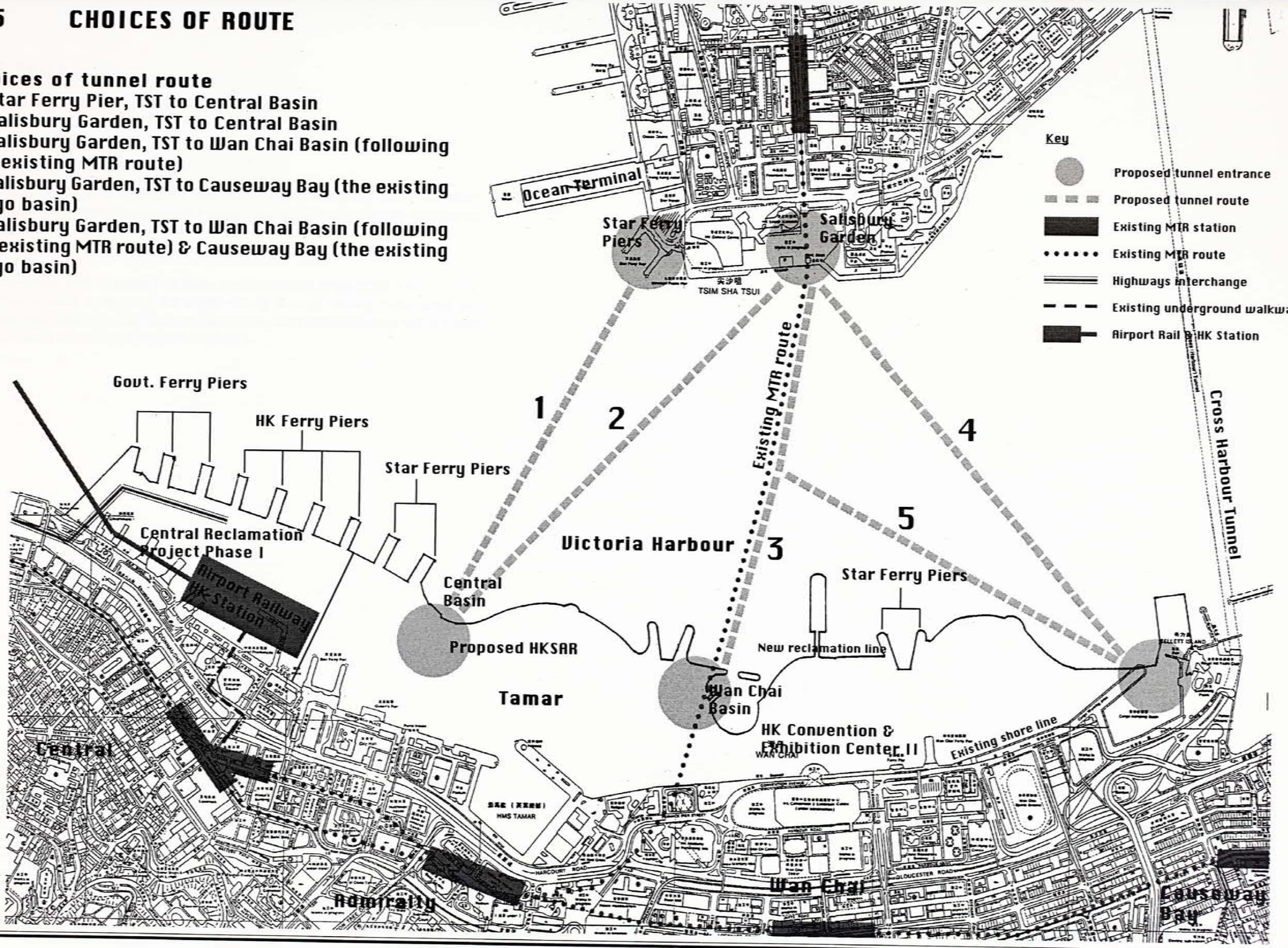
Proposed tunnel entrance

Potential linkage

2.5 CHOICES OF ROUTE

Choices of tunnel route

1. Star Ferry Pier, TST to Central Basin
2. Salisbury Garden, TST to Central Basin
3. Salisbury Garden, TST to Wan Chai Basin (following the existing MTR route)
4. Salisbury Garden, TST to Causeway Bay (the existing cargo basin)
5. Salisbury Garden, TST to Wan Chai Basin (following the existing MTR route) & Causeway Bay (the existing cargo basin)



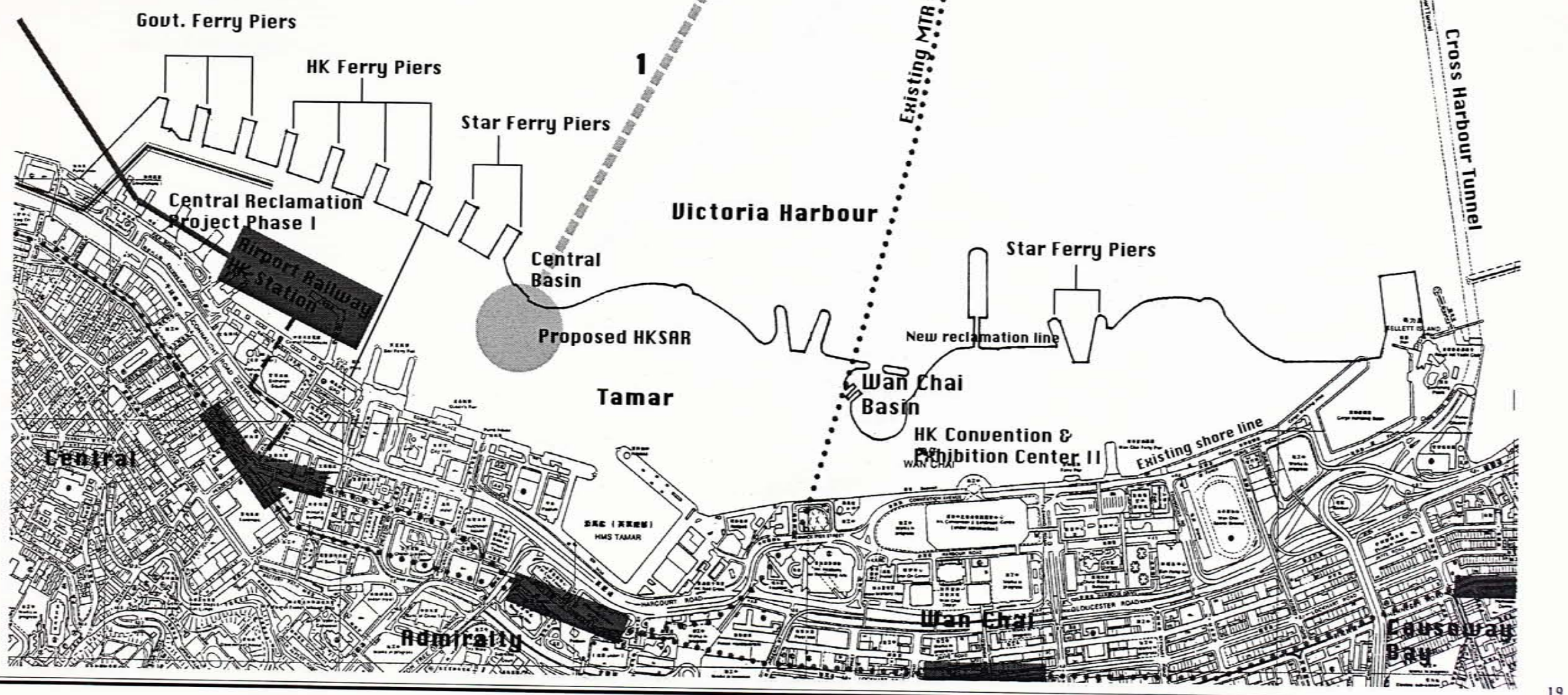
2.5.1 Route 1

Star Ferry Pier (TST) to Central Basin

Distance: 1100 m

<u>Star Ferry Pier (TST)</u>
The entrance will connect to existing shopping mall (Ocean Terminal), bus terminal, Star Ferry Pier and pedestrian walkway that along the waterfront.

<u>Central Basin</u>
The entrance will connect to new reclamation area (CBD extention); fly-overs will connect to new Hong Kong Ferry Pier and its commercial development, bus terminal, Airport Railway Hong Kong Station and existing Central District.



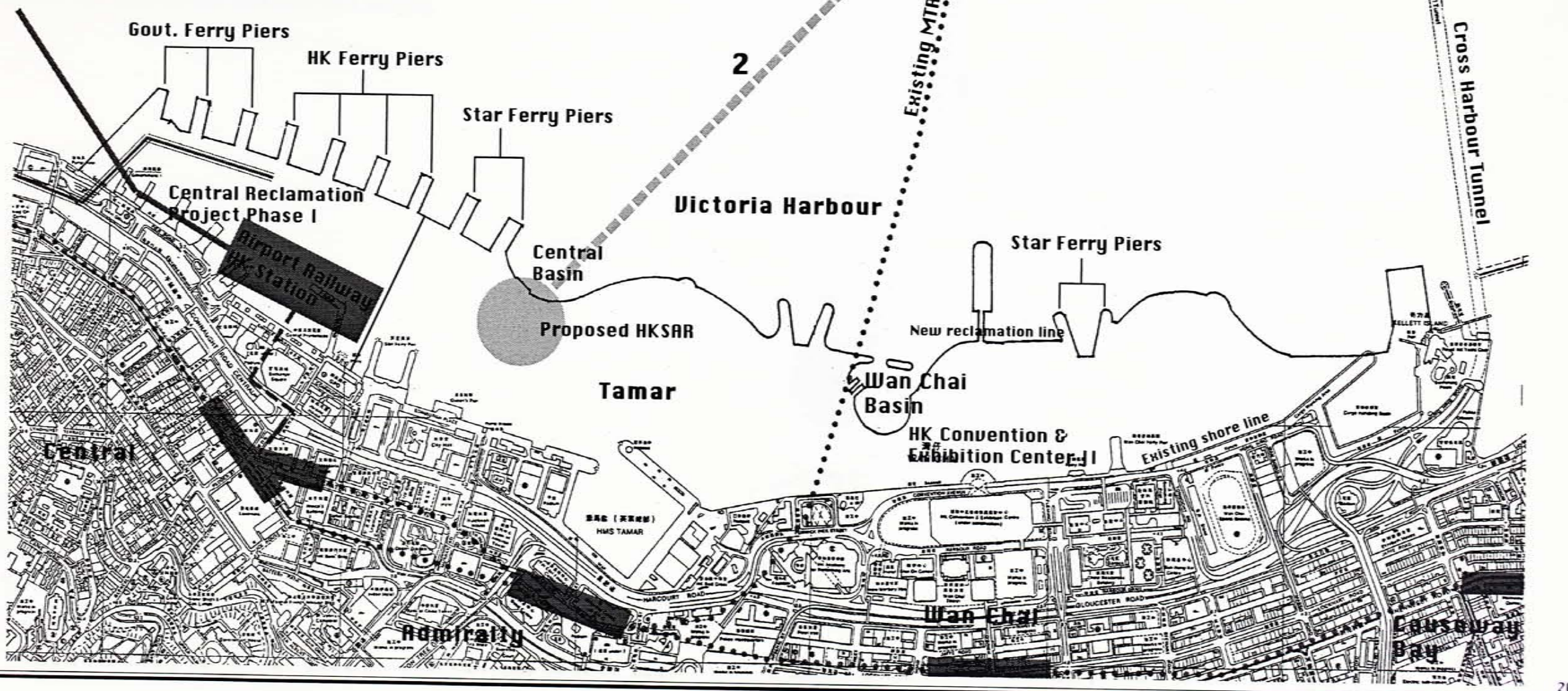
2.5.2 Route 2

Salisbury Garden (TST) to Central Basin

Distance: 1300 m

<u>Salisbury Garden</u>
The entrance will locate at the existing Salisbury Garden. Underground development will form the major element of the entrance and will connect to the surrounding major roads at ground level and shopping malls at basement level.

<u>Central Basin</u>
The entrance will connect to new reclamation area (CBD extention); fly-overs will connect to new Hong Kong Ferry Pier and its commercial development, bus terminal, Airport Railway Hong Kong Station and existing Central District.



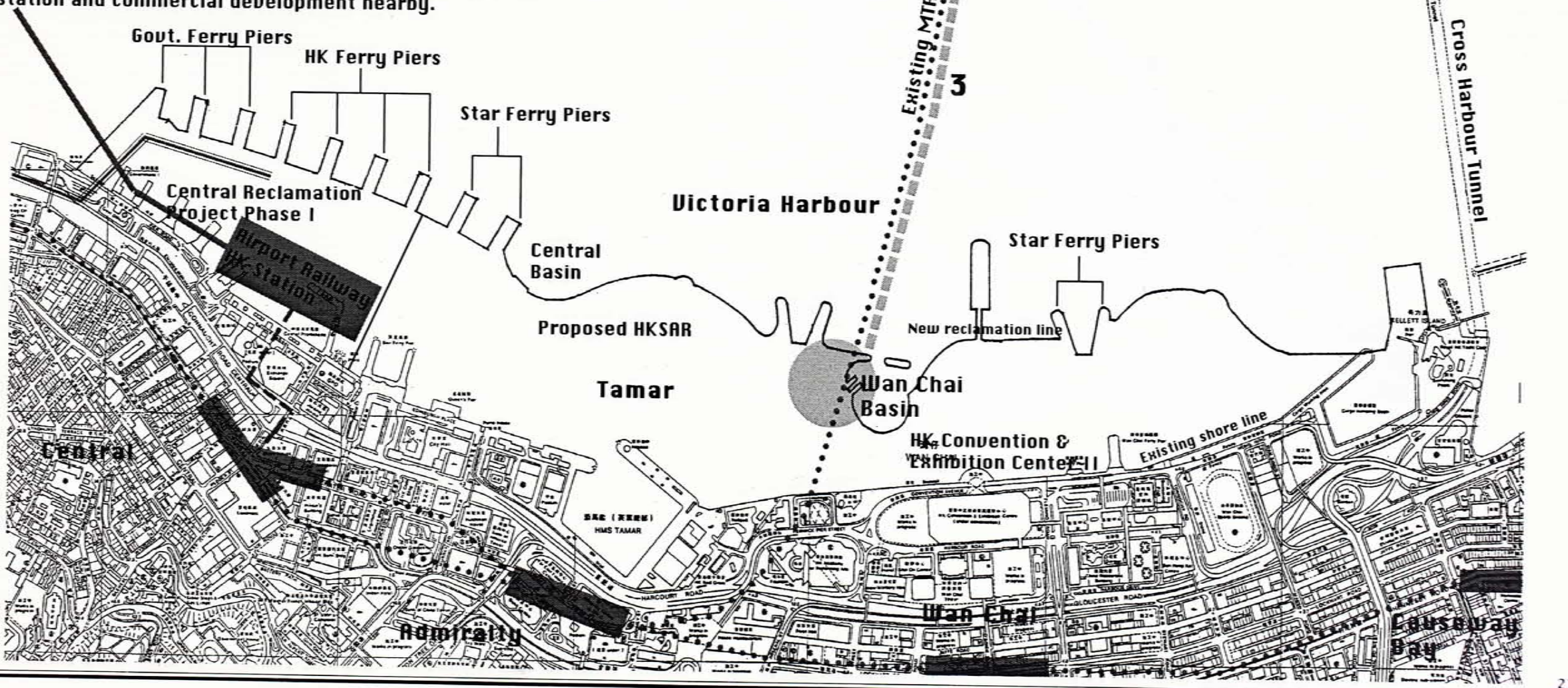
2.5.3 Route 3

Salisbury Garden (TST) to Wan Chai Basin

Distance: 1100 m

<u>Salisbury Garden</u>
The entrance will locate at the existing Salisbury Garden. Underground development will form the major element of the entrance and will connect to the surrounding major roads at ground level and shopping malls at basement level.

<u>Wan Chai Basin</u>
Entrance at Wan Chai Basin will locate at the new reclamation area and will connect to the proposed HKSAR and HK Convention and Exhibition Center nearby. Underground tunnel have potential to follow the existing MTR route and extent to Admiralty and its MTR station and commercial development nearby.



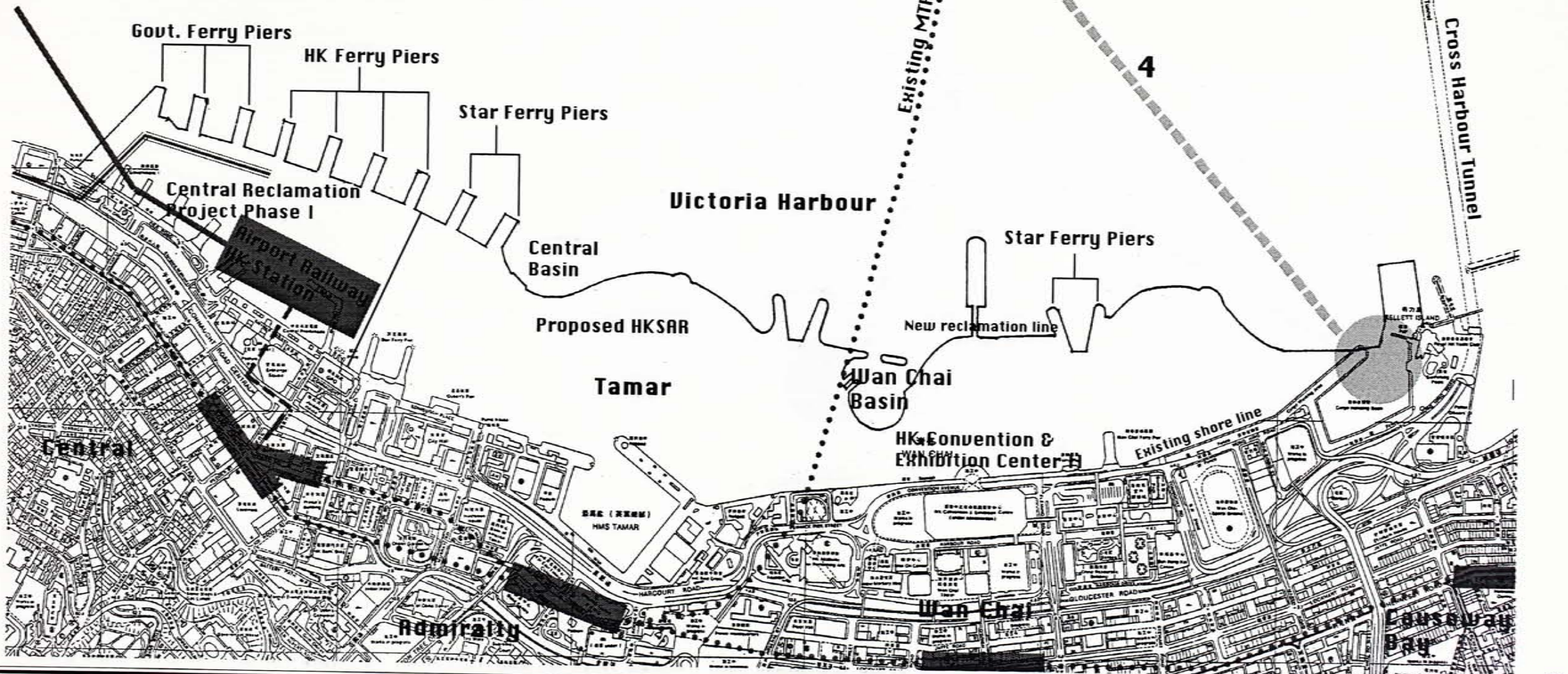
2.5.4 Route 4

Salisbury Garden (TST) to Causeway Bay

Distance: 1300 m underwater
600 m underground (from waterfront to Yee Wo Street)

<u>Salisbury Garden</u>
The entrance will locate at the existing Salisbury Garden. Underground development will form the major element of the entrance and will connect to the surrounding major roads at ground level and shopping malls at basement level.

Causeway Bay
The entrance will locate at the existing cargo handling basin. Underground tunnel will start from here and extent to existing Causeway Bay MTR Station and shopping malls at basement level.

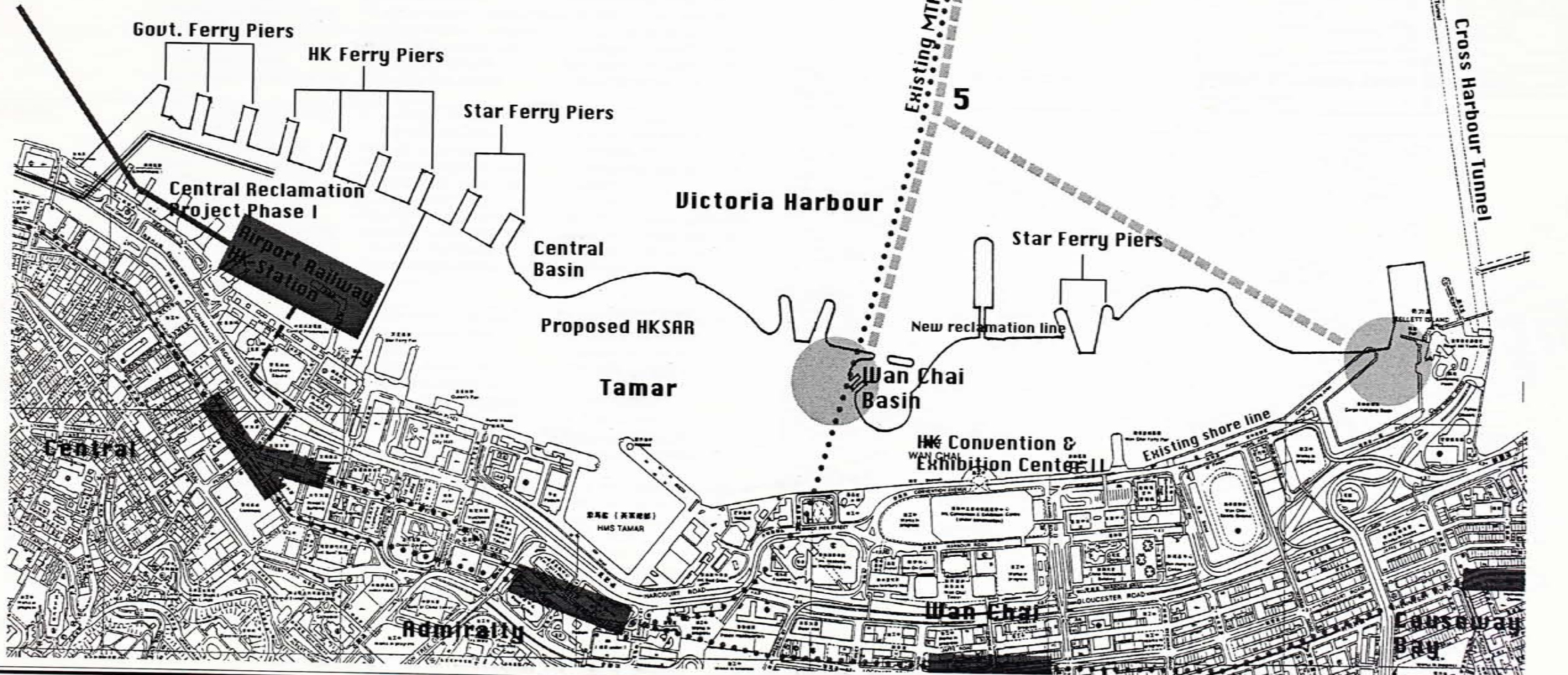


2.5.5 Route 5

Salisbury Garden (TST) to Wan Chai Basin & Causeway Bay

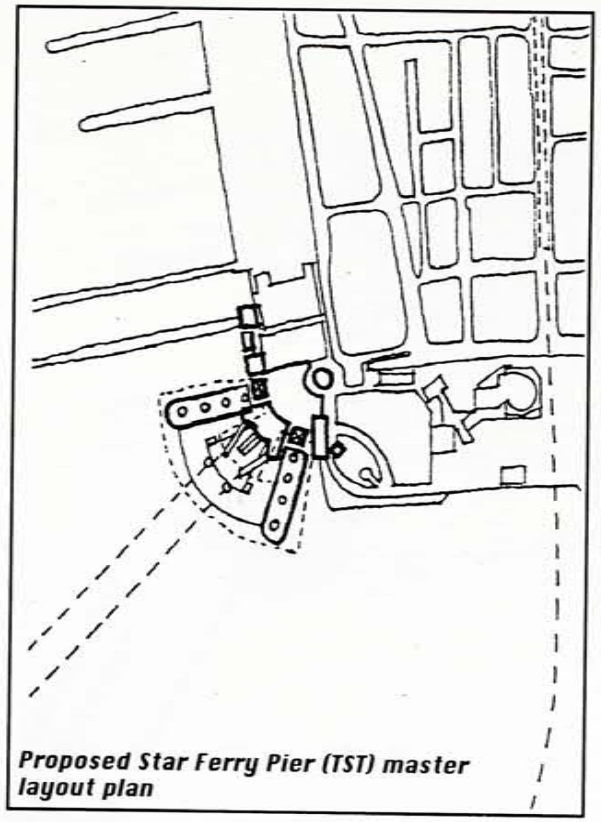
Distance: 500 m Salisbury Garden to Harbour MTR Station
600 m Harbour MTR Station to Wan Chai Basin
900 m Harbour MTR Station to Causeway Bay

The combination of route 3 and route 4. A new MTR Station will located at the middle of Victoria Harbour and serve as a junction and transport interchange point from TST to either Wan Chai or Causeway Bay.

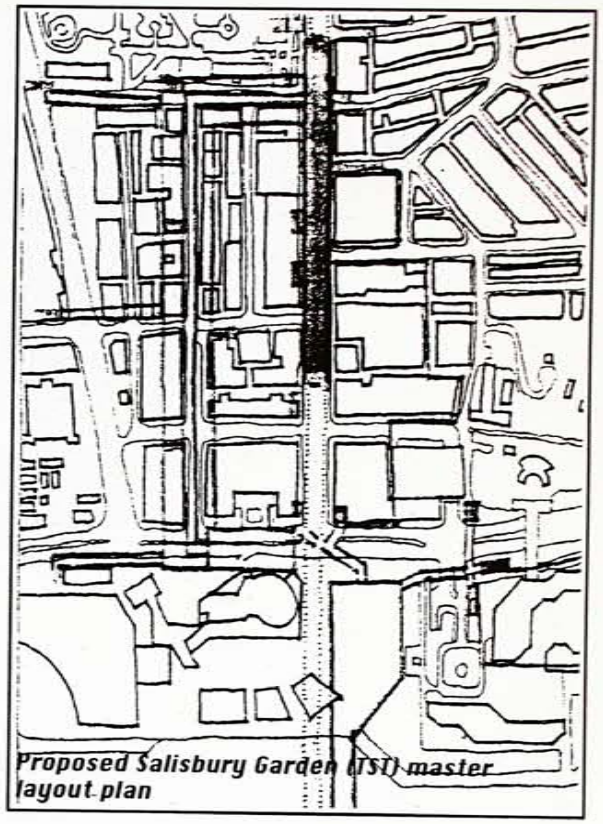


2.6 MATRIX

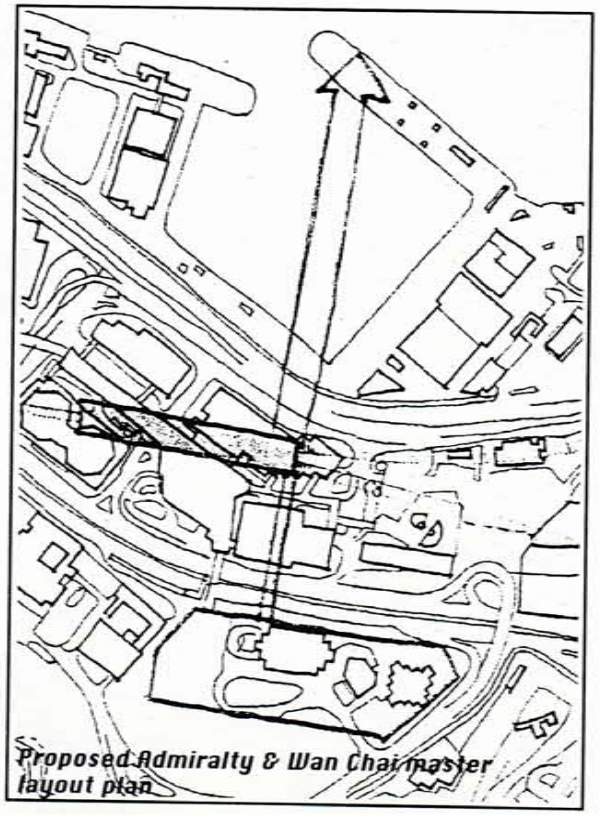
	Potential development	Pos.	Cons.
Star Ferry Pier, TST	1. redevelop the existing ferry pier, bus terminal, and Clock Tower plaza 2. potential to build underground walkway and shopping arcade to link with MTR, Peking Road, Nathan Road 3. in long term development, it can think about how to link with TST East and the West Kowloon Reclamation project	1. close to the existing shopping street and Ocean Terminal 2. the existing site has bus terminal, ferry pier and is well known to the public and tourist, i. e. very suit to locate the entrance 3. the Planning Dept. propose to have a reclamation project and will benefit to the tunnel 4. close to the waterfront pedestrian walkway and the cultural facilities	1. need small reclamation to house the redevelopment of bus terminal and the ferry pier 2. far away from Nathan Road and MTR station
Salisbury Garden, TST	1. redevelop the existing Salisbury Garden 2. directly link with TST MTR station 3. directly link with New World Center and the cultural facilities nearby 4. using the same route of existing MTR for the pedestrian tunnel, additional MTR station can be built	1. close to Nathan Road, just like to extend Nathan Road 2. close to the waterfront pedestrian walkway and New World Center 3. not to long in connecting Central or Causeway Bay 4. TST MTR station will bring lot of people entering the tunnel	1. the existing MTR route is too crowded, the tunnel will only increase the traffic load of MTR because lot of people will have interchange from MTR to the pedestrian tunnel 2. create lot of technical problem in construction because it is built on top of the MTR route.
Central Basin	1. the tunnel can connect to the HK Ferry Pier development and the Airport Rail Hong Kong Station 2. the tunnel can connect to the proposed HKSAR 3. the tunnel can directly connect to the existing Central near Status Square and the existing fly-over system	1. shortest distance to TST 2. the CBD will have highest pedestrian flow both for shoppers and people work in Central 3. the tunnel itself, together with other transport facilities, will create a transport interchange system within the district	1. limited human activities at night and every weekend, this will limit the commercial value of the tunnel 2. retail type of the existing Central shopping mall are mainly high class and will restrict the development potential
Wan Chai Basin	1. connect to new CBD 2. use fly-over to connect HK Convention & Exhibition Center 3. connect to Admiralty by extent the tunnel at basement level	1. the tunnel can connect both Wan Chai and Admiralty 2. high pedestrian flow when the tunnel can connect to the existing MTR station	1. the project is extremely complicated when connecting the tunnel to the MTR station or build a new station in the middle of the harbour. 2. low commercial value compare to other site
Causeway Bay	1. the pedestrian tunnel can directly connect to the Causeway Bay MTR station 2. it is possible to connect many existing basements of the shopping malls and department store	1. the highest marketing value in retail trade because there are a lot of famous shopping malls and department store in Causeway Bay 2. the site is closed to the entrance of the cross harbour tunnel and help to attract people to go to the tunnel	1. longest distance from TST 2. if the tunnel connect to the Star Ferry Pier, TST, it will across the existing MTR route and cause a lot of technical issues 3. the underground condition in Causeway Bay is too complicated and no additional space for locating the building services



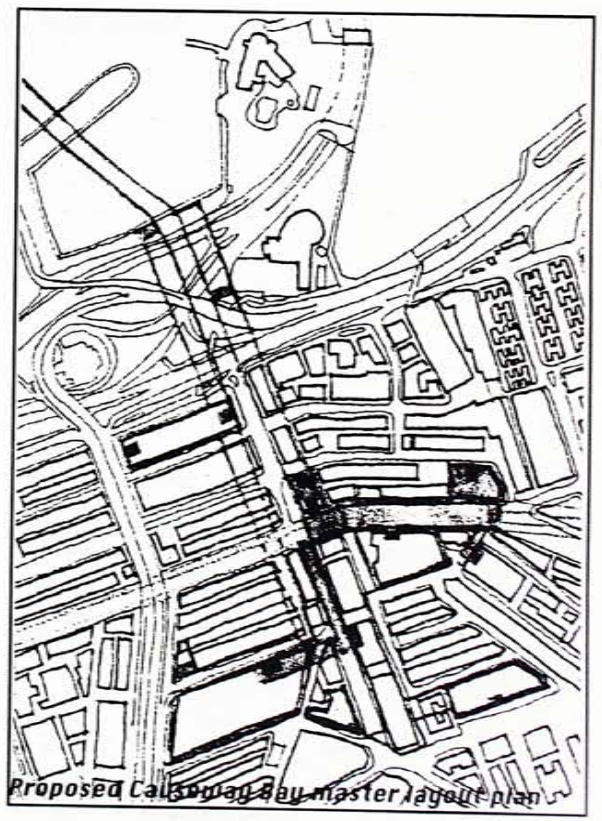
Proposed Star Ferry Pier (TST) master layout plan



Proposed Salisbury Garden (TST) master layout plan



Proposed Admiralty & Wan Chai master layout plan



Proposed Causeway Bay master layout plan

2.7 FINAL DECISION & SITE ANALYSIS

2.7.1 Final Decision

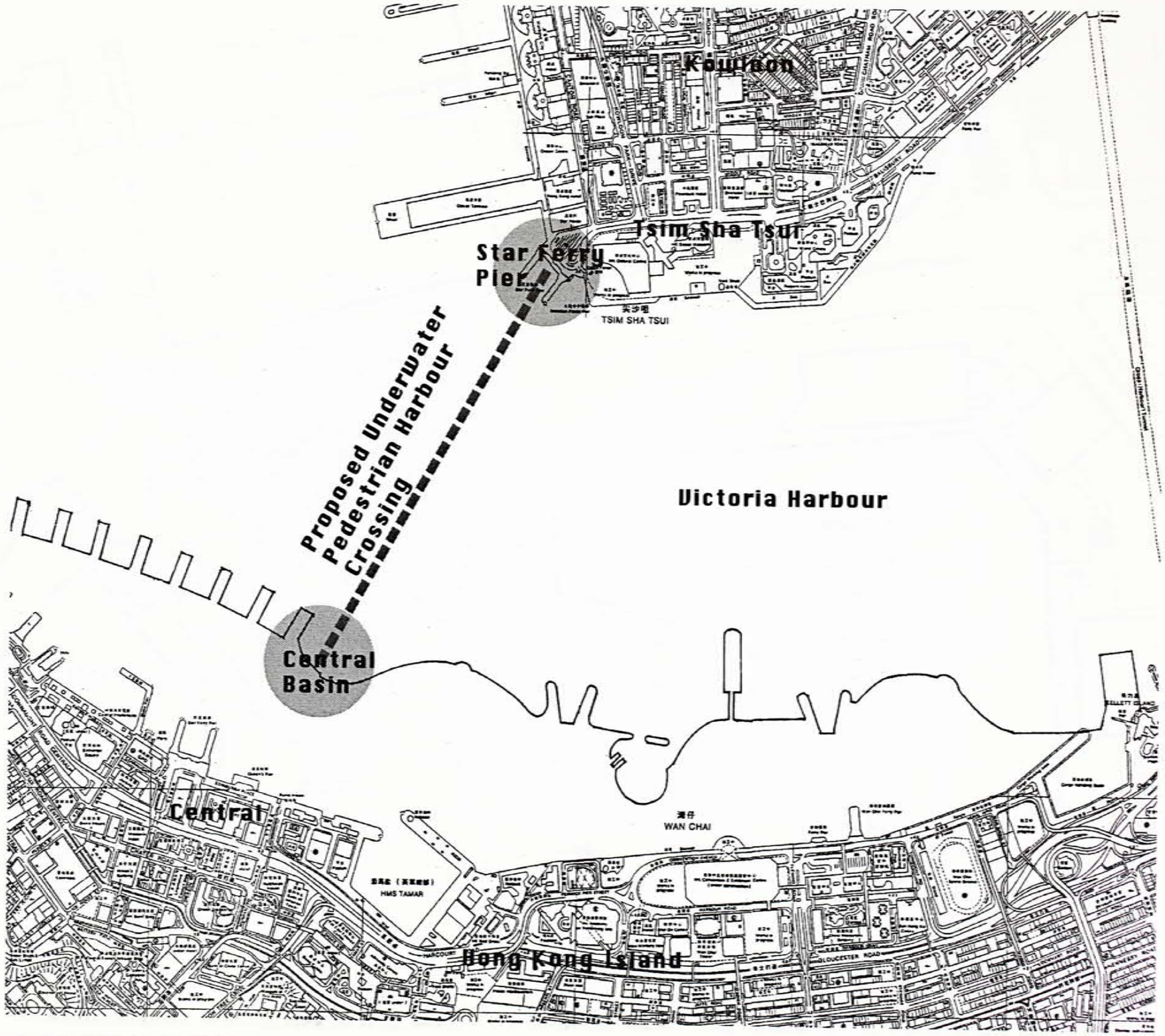
Route 1 Star Ferry Pier to Central Basin (1,100 m)

Advantages:

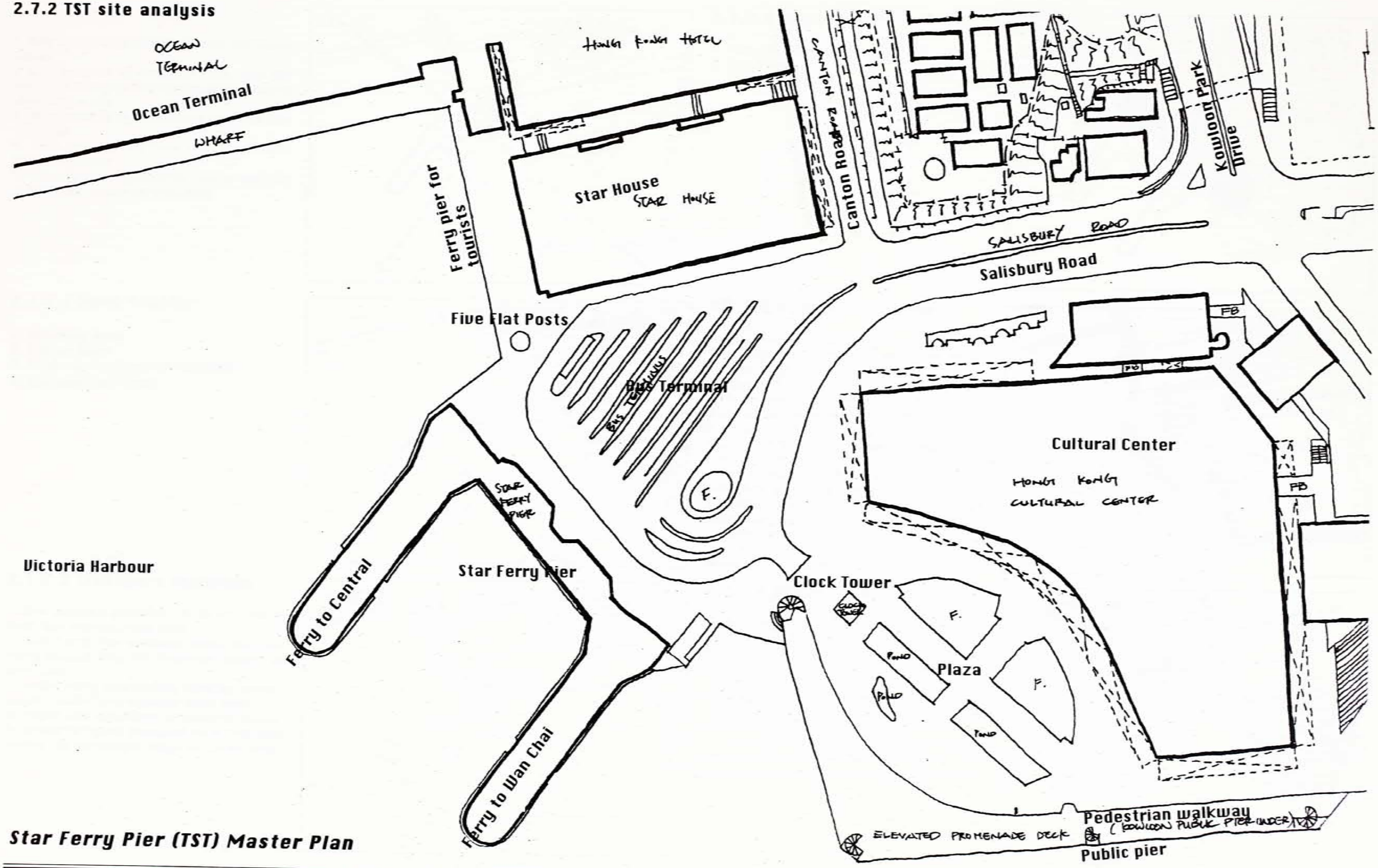
1. This route has the shortest distance among the five routes.

2. Less technical problems compare to the other routes as the other routes' entrances are connected at busy street with limited land. Besides, those routes are proposed to connect to the existing MTR route or need to create another station and it will increase the complexity of the project.

3. Very high pedestrian flow in the existing site in both two sides of the proposed tunnel entrances. As the two sites are located just next to famous shopping malls, bus terminals, ferry piers, mass transport 's station and famous pedestrian walkway, it is suitable to locate the tunnel entrance in those places and attract people to use the tunnel. As a result, the tunnel itself can be developed not only a cross harbour link but also a high commercial value 's development.

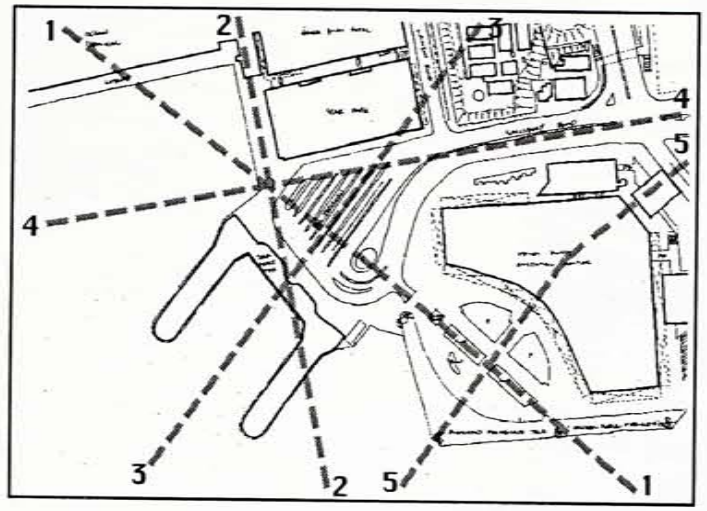


2.7.2 TST site analysis



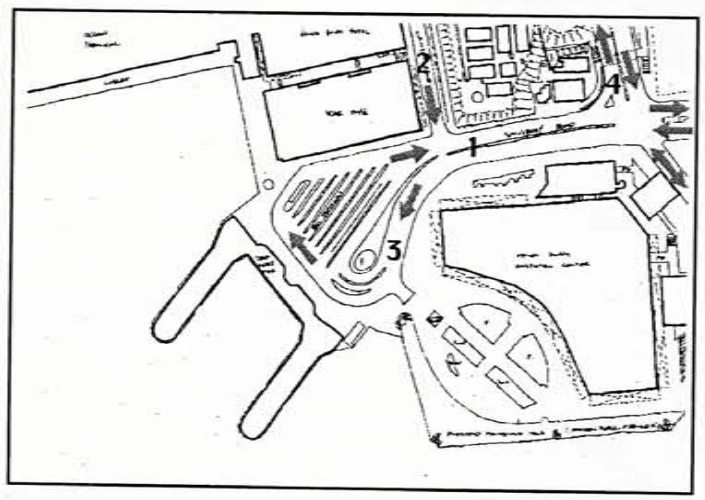
2.7.2.1 Axis

1. Axis created by Five Flat Posts and Clock Tower
2. Axis created by Five Flat Posts and the entrance of Ocean Terminal and the related shopping malls
3. Axis created by Star Ferry Pier and bus terminal
4. Axis created by Five Flat Posts and Salisbury Road
5. Axis created by Cultural Center and the pedestrian elevated walkway



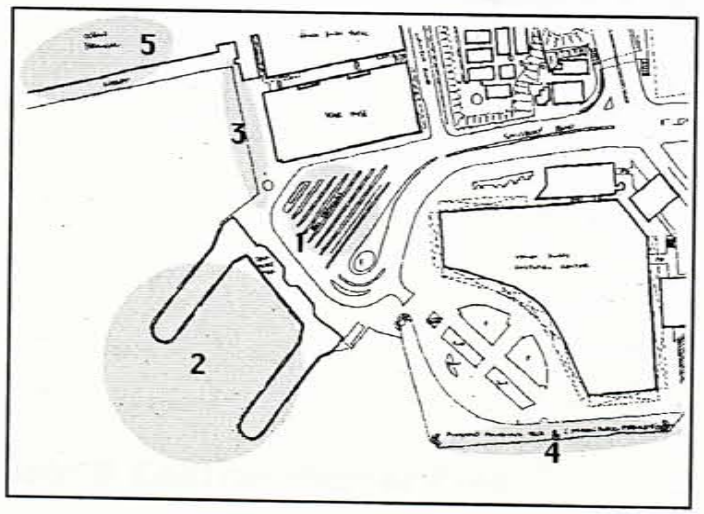
2.7.2.2 Road traffic

1. Salisbury Road
2. Canton Road
3. Road surrounding bus terminal
4. Kowloon Park Drive



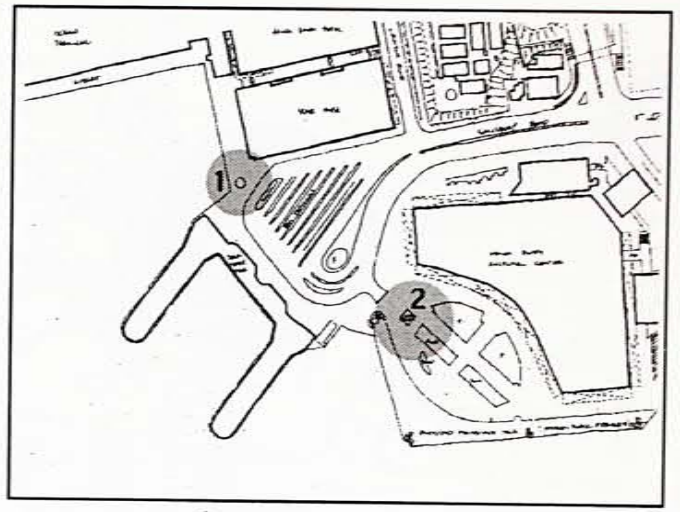
2.7.2.3 Transport facilities

1. Bus terminal contains 15-20 bus route, mini-bus station, taxi stop
2. Star Ferry Pier provides cross harbour ferry service from TST to either Central or Wan Chai
3. Public ferry pier mainly used by tourist boats for Victoria Harbour boat tours
4. Public pier provided for general public
5. Ocean Terminal provided as a ship pier either for passenger ships or cargo ships



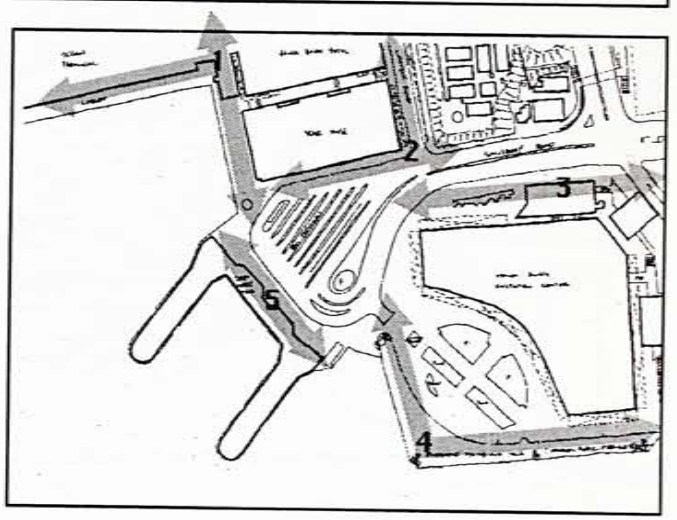
2.7.2.4 Landmarks

1. Five Flat Posts
2. Clock Tower



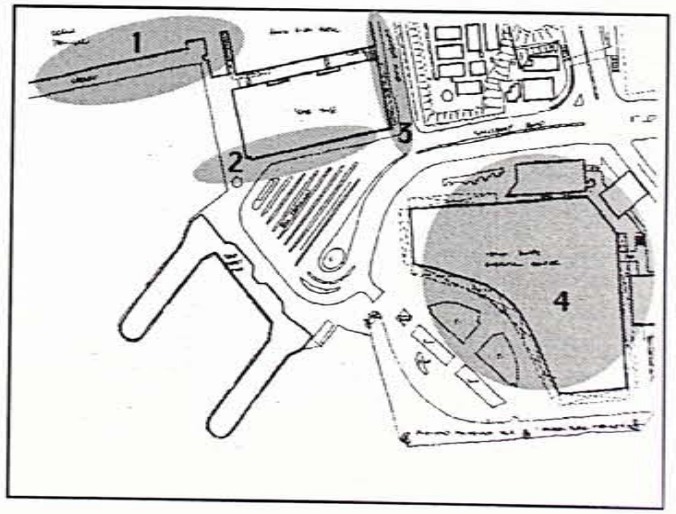
2.7.2.5 Pedestrian fluidity

1. Pedestrian movement from Five Flat Posts (ground Level) to shopping malls (podium level). People are mainly shoppers.
2. Pedestrian movement along Star House and Canton Road at street level
3. Pedestrian movement along Salisbury Road and they are mainly come from Nathan Road or TST East
4. Pedestrian movement along pedestrian elevated walkway along the waterfront at both ground level and elevated walkway level
5. Pedestrian movement along Star Ferry Pier and those people mainly are ferry users

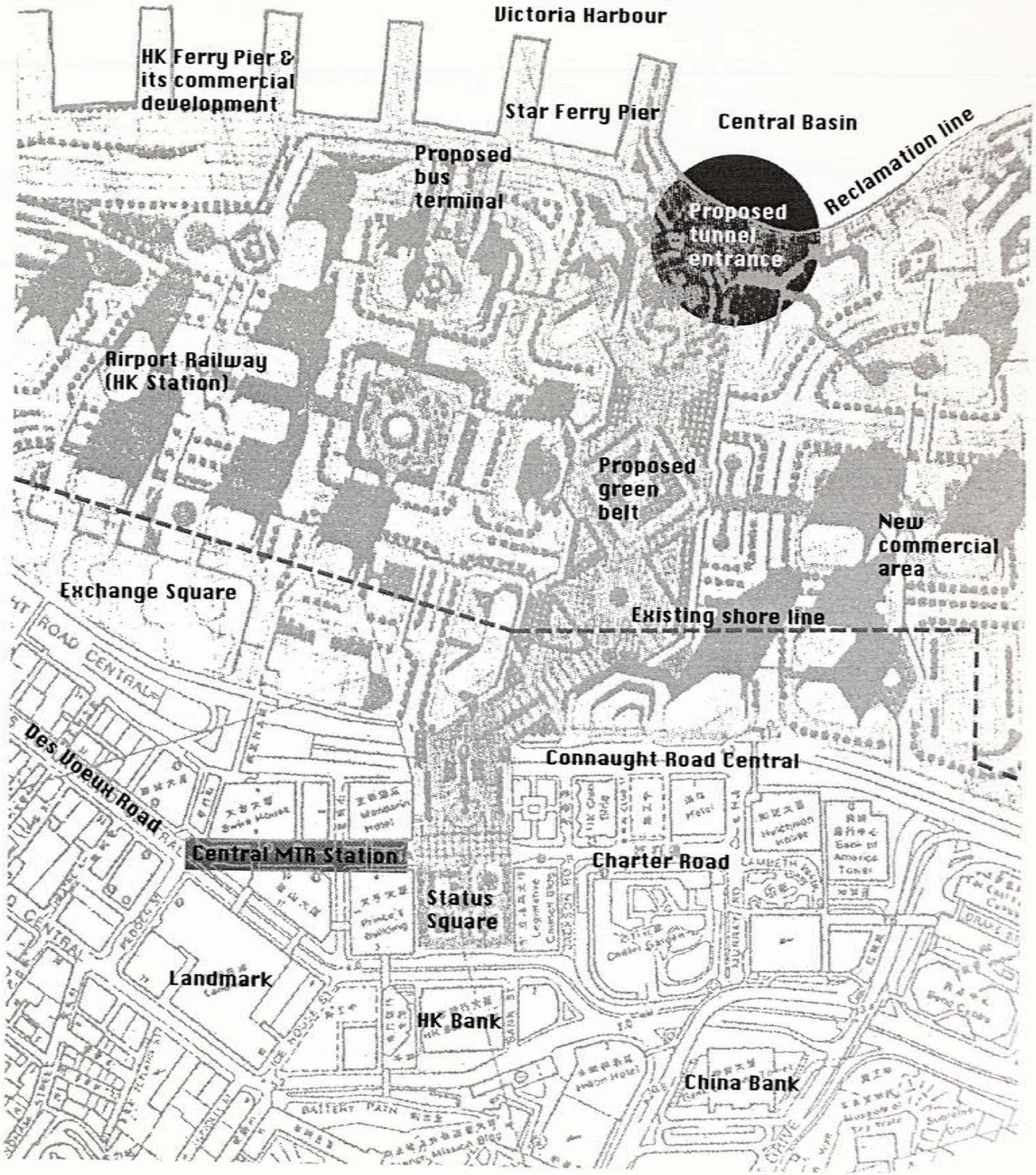


2.7.2.6 Other facilities

1. Ocean Terminal together with pier outside, shopping arcades inside and carpark on the roof
2. Street shopfronts together with shops major selling computer, restaurants in podium level of Star House
3. Famous restaurants, cinemas, and high class retails along Canton Road
4. Cultural facilities include Cultural Center, Space Museum, Art Museum, Art Library and so on along Salisbury Road



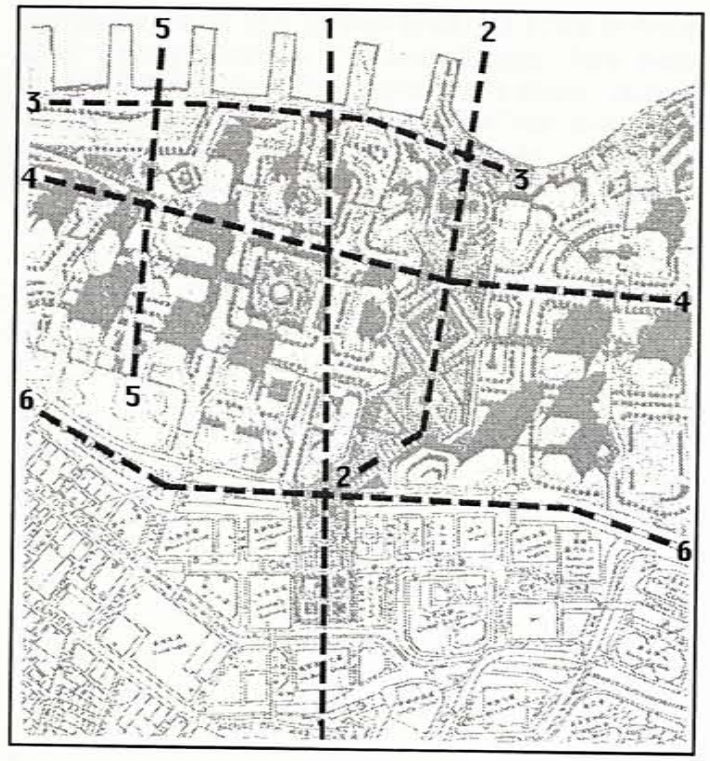
2.7.3 Central site analysis



Central Basin & Central Master Plan

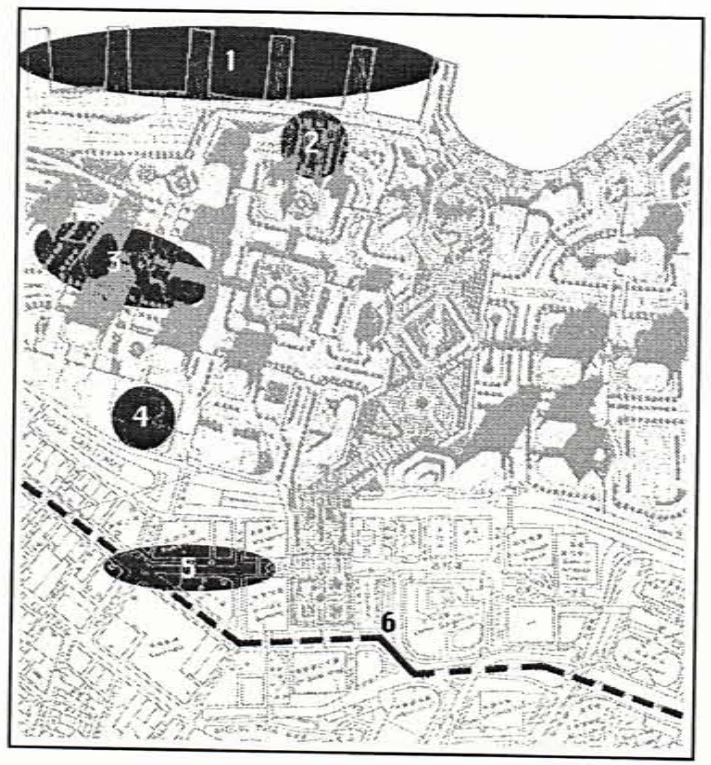
2.7.3.1 Axis

1. Axis created by HK Bank, Status Square and the related open space. This is the most important axis in Central.
2. Axis created by the proposed green belt which will surround by high-rise commercial buildings extrude from the reclamation area
3. Axis created by the waterfront and series of ferry piers
4. Axis created by the major road which will locate at the middle part of the new reclamation area
5. Axis created by the Airport Railway (HK Station) and the commercial development of the HK Ferry Pier
6. Axis created by the existing Central district and the new reclamation district



2.7.3.2 Transport facilities

1. HK Ferry Pier and Star Fery Pier
2. Proposed bus terminal
3. Airport Railway (Hong Kong Station)
4. Existing bus terminal in Exchange Square
5. MTR Central Station
6. Tramway

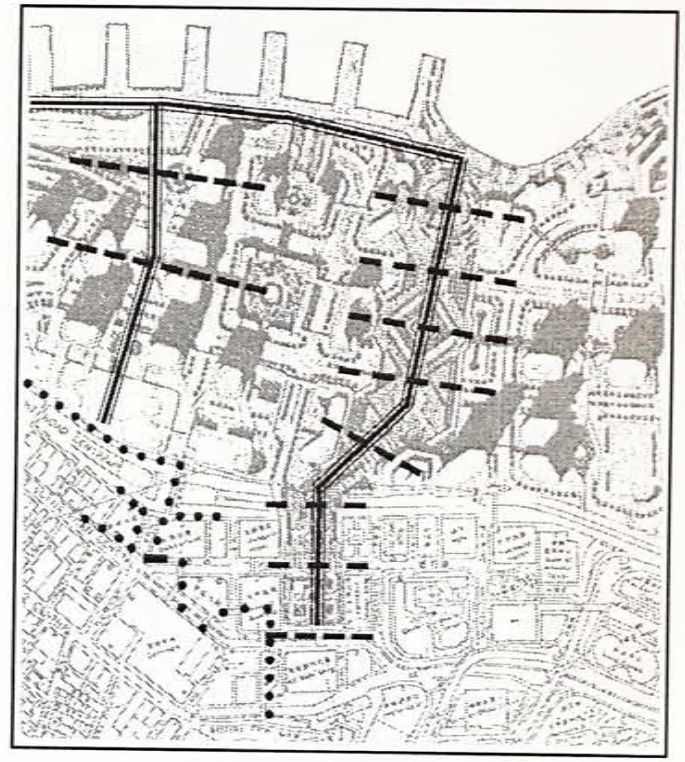


2.7.3.3 Pedestrian fluidity

Pedestrian movement mainly on foot bridge level which will connect major buildings like Airport Railway HK Station, Ferry Pier, Bus Terminal, Elevated green belt, Status Square

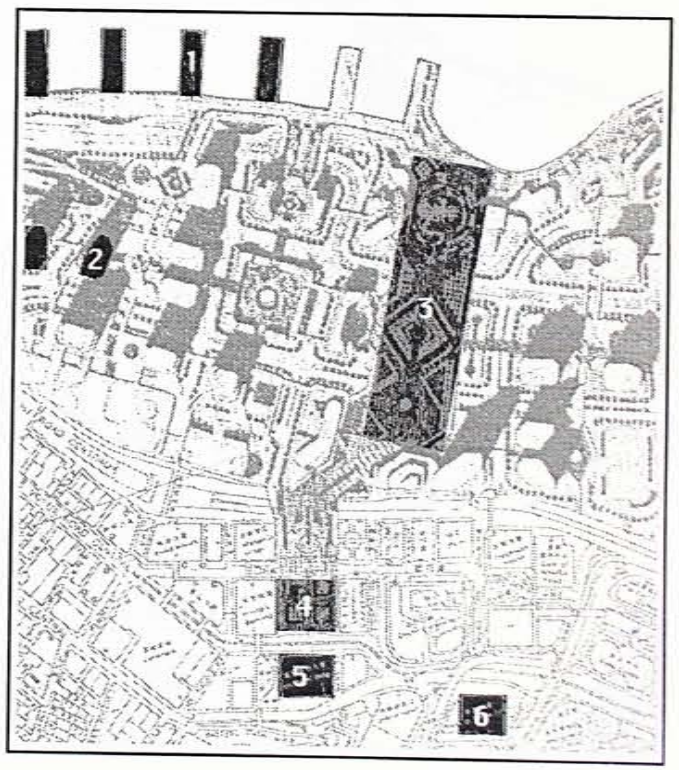
Pedestrian movement at ground level and will either go to or come from foot bridges that described as above

Pedestrian movement in existing elevated walkway which connect the commercial buildings at podium level



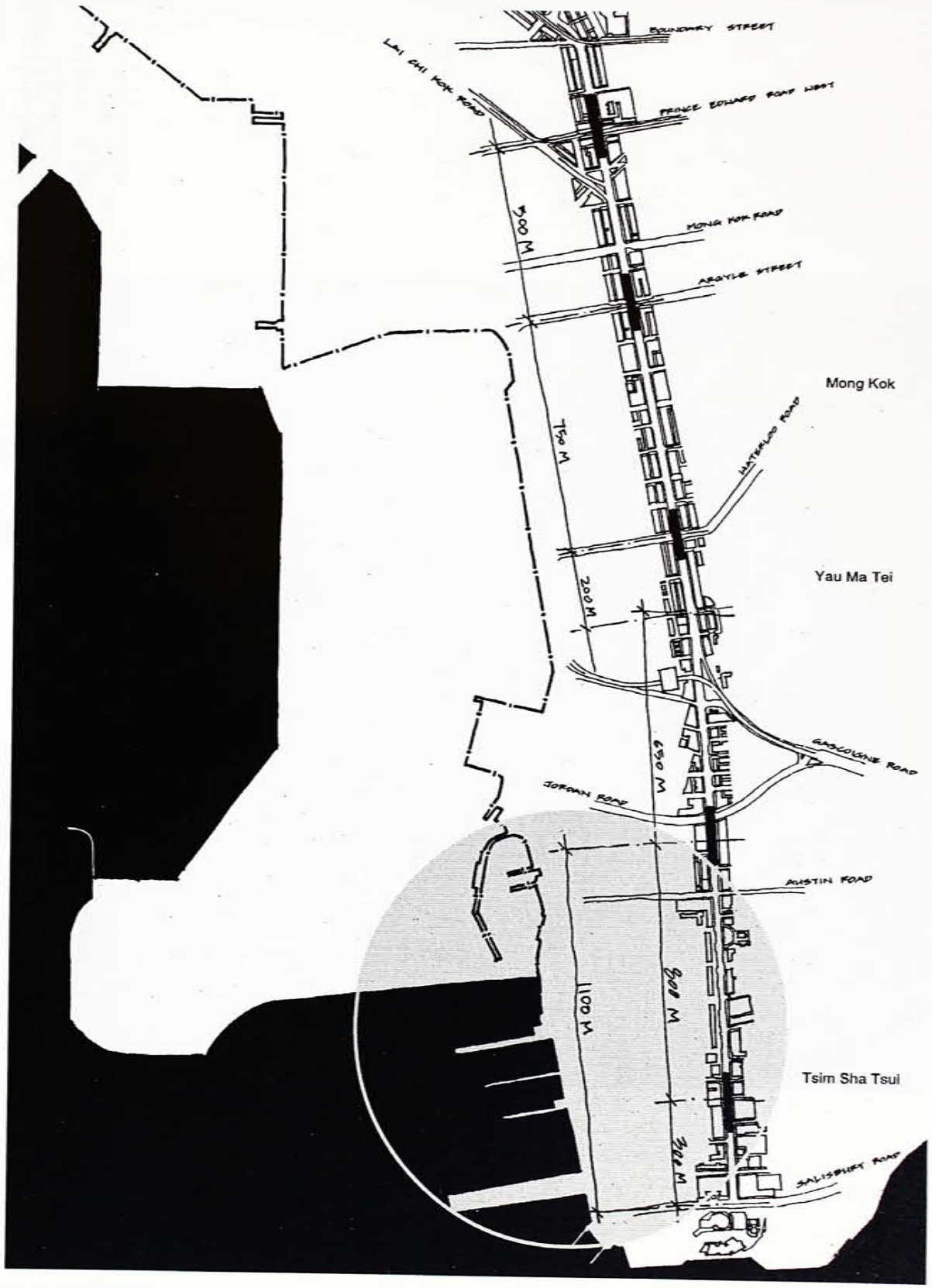
2.7.3.4 Landmark

1. HK Ferry Pier and its commercial development
2. Airport Railway Hong Kong Station and its higg-rise office development
3. Green Belt which will locate in the middle of the reclamation area and connect to the Status Square
4. Statue Square
5. Hong Kong Bank
6. China Bank



2.7.4 Distance of the tunnel

The distance of the tunnel is about 1100 m from Star Ferry Pier to Central Basin (the new reclamation area). This distance is equal to part of the Nathan Road from Tsim Sha Tsui to Jordon. People will need about 16 minutes to walk 1100 m (1 m per second).



Distance of Nathan Road compare with the proposed tunnel

CHAPTER 3 RESEARCH AND FIELD WORKS

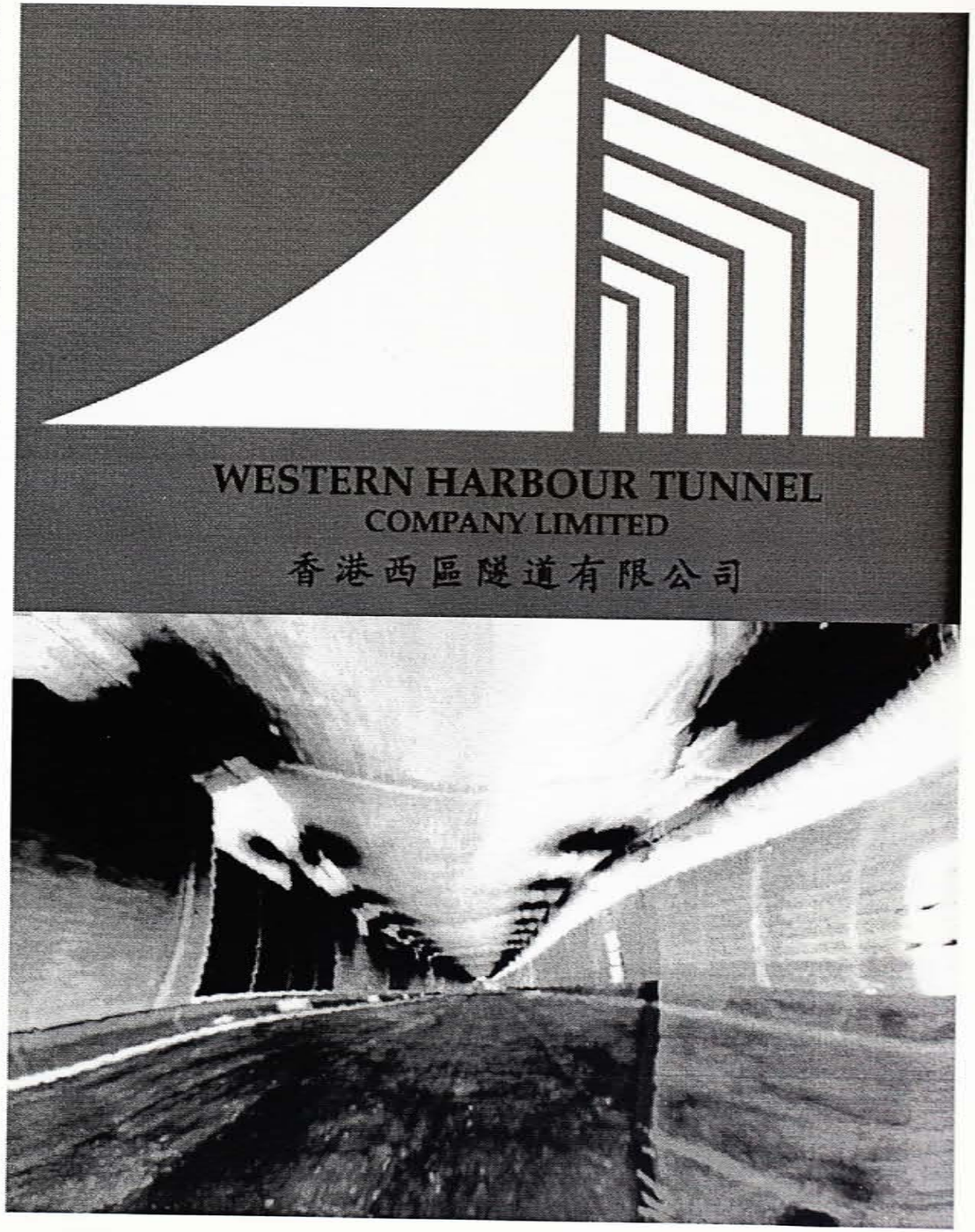
3.1 UNDERWATER TUNNEL CONSTRUCTION (WESTERN HARBOUR CROSSING)

3.1.1 Intoduction

When completed in 1997, the Western Harbour Crossing will become the third road connection between Hong Kong Island and the rest of the Territory, and a vital part of the Airport Core Programme, (ACP), joining the island with Hong Kong's replacement airport currently being built at Chep Lap Kok.

The 2 km long tunnel, which will have a maximum daily capacity of 180,000 vehicles, will be the first dual, three-lane immersed tube to be built in South East Asia. It is also the first time that a privately funded, Build Operate and Transfer (BOT) project has been included in the ACP.

The contract has been split into three sections: the twin, three-lane immersed tube construction and placing; the approach works at West Kowloon; and the approach roads and associated infrestructure works on the Hong Kong Island at Sai Ying Pun, Western. In 1993, the Hong Kong Government let a 30-year franchise to the Western Harbour Tunnel Company to provide and operate the crossing. The Tunnel company in turn awarded a contract to the Nishimatsu Kumagai Joint Venture to design and construct the project in a period of just 47 months. The Joint Venture engaged Maunsell-Acer-Parsons Brinkerhoff as the contractor's designers, and also awarded contracts to Nishimatsu Construction Ltd and Gammon Construction Ltd for the civil works on the West Kowloon side, across the Harbour and on Hong Kong respectively.



Western Harbour Crossing

Source: *Western Harbour Crossing*, A commemorative publication for the Nishimatsu Kumagai Joint Venture, 1996

3.1.2 Project description

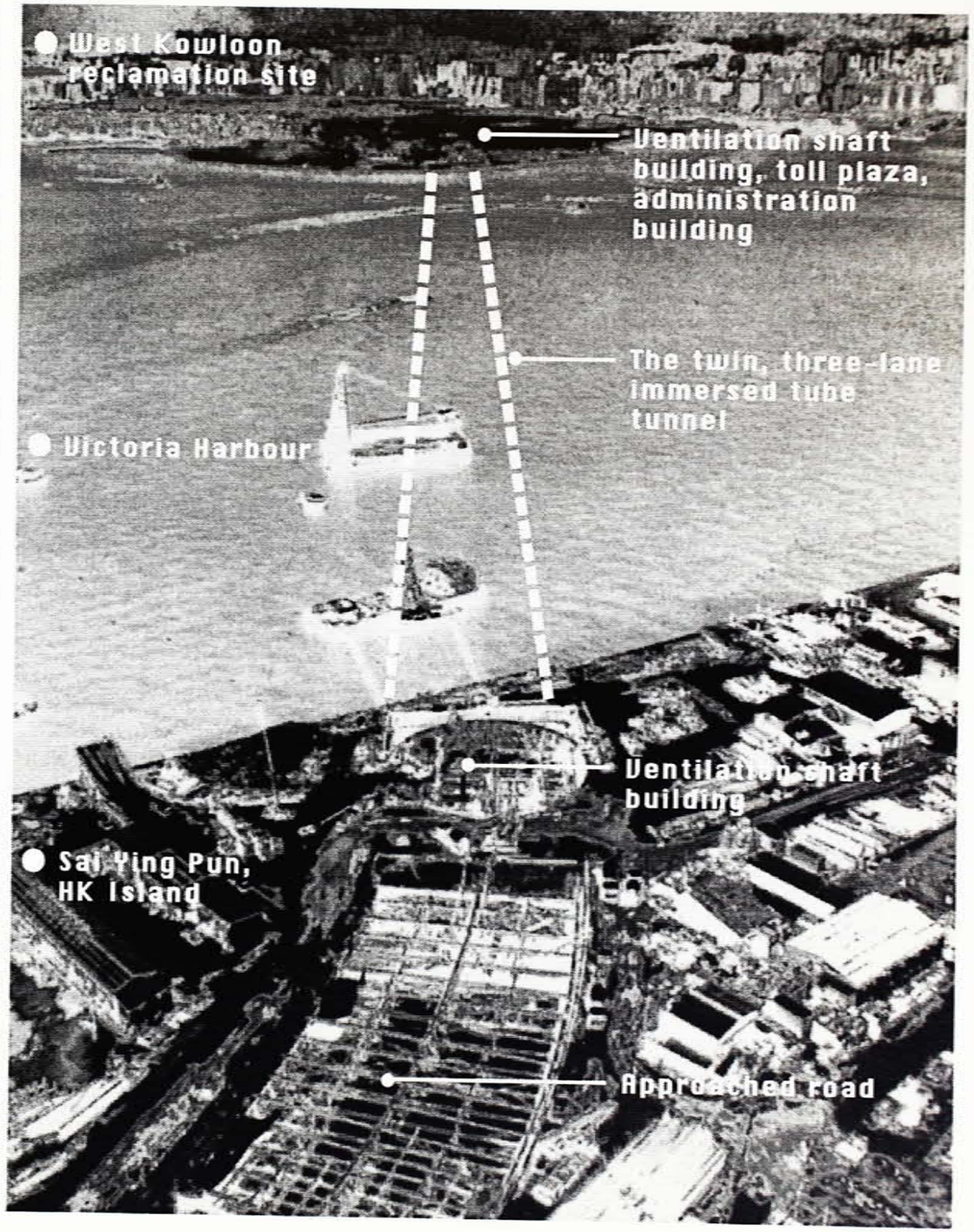
On the West Kowloon side, the project connects with the southern end of the Kowloon Expressway and fans out to a 20-lane toll plaza with canopy, footbridge and covered bus bays. The four central lanes are reversible to accommodate peak traffic flows. A three-storey administration building is the control center for the tunnel and approaches, and accommodates systems to oversee traffic control and surveillance, power, ventilation and lighting as well as toll collection. The building also houses administration staff, maintainance and repair facilities.

An open ramp section runs from the plaza to a cut and cover tunnel, approximately 200 m long. From here the route passes through the base of the ventilation shaft sited on the West kowloon landfall.

The pre-cast concrete immersed tube tunnel is 1.3 km long and comprises twelve, 113 m long sections, running in a straight south-westerly direction. The tunnel dips to the low point under the center of Victoria Harbour rising to a landfall at Sai Ying Pun through the base of a second ventilation shaft.

Tunnel sections were cast in a specially adapted disused quarry basin at Shek O and when complete, were floated to a temporary holding area at Junk Bay. When the necessary dredging of the harbour floor had been completed, the tunnel sections were floated out to the required position, lowered to the sea bed and attached to previousy placed sections.

On the Hong kong Island side, the route runs from the ventilation shaft through a 300 m length of cut and cover tunnel. It emerges onto an open ramp section and a complex of elevated and at grade roads, feeding traffic to and from the Central Business District and to west Hong Kong Island.



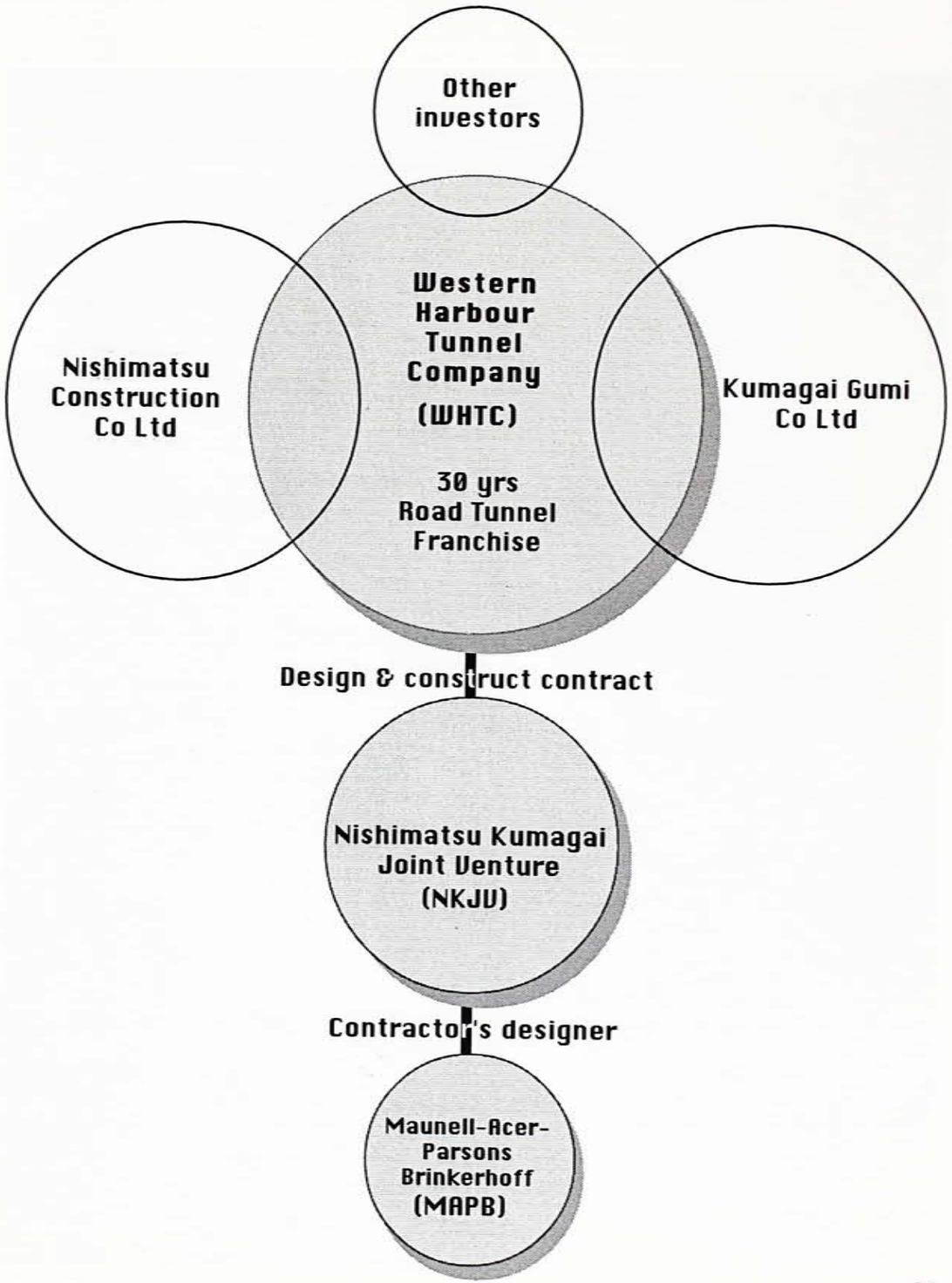
Source: *Western Harbour Crossing*, A commemorative publication for the Nishimatsu Kumagai Joint Venture, 1996

3.1.3 Build, Operate and Transfer contract

One of the main advantages of a BOT design and construct contract over normal contracting is the rapid, phased development of the design in the order which best suits the required construction sequence. This kind of process is well proven and the Western Harbour Crossing is now the third franchised tunnel project in Hong Kong. An agreement is reached between the designer, the Government representative, the contractor and the independent checking engineer on the division of the project into distinct elements.

The designer then prepares conceptual design based on the contractors preferences, and these are submitted to the Government representative for Approval in Principle. When, and if the Approval in Principle is recieved, the detailed design of each particular element can be developed and passed to the design checker for checking and certification. Approval at this stage allows the release of the working drawings. Work started on the ground excavation for the two ventilation shafts in February 1994 and the whole scheme is expected to be open to traffic in 1997.

The two principal contractors for the Western Harbour tunnel Crossing Project, Nishimatsu Construction Co Ltd and Kumagai Gumi Co Ltd have a wealth of experience in major infrastructure projects all over the world. During the early stages of the scheme's promotion, both Nishimatsu and Kumagai were prepared to take equity portions but were looking to share the investment with others. Neither company was looking for a long term position in the Build Operate and Transfer (BOT) scheme but were happy to use their vast experience of cost effective design management; using fast track construction techniques to pass on the benefit of this knowledge to the investors. No one doubts the effectiveness of BOT schemes to both Governments and the wider community. The main advantages being the immediate construction of infrastructure projects without Government bearing the direct cost of the project, and with all the technical and financial risks being retained by the private sector promoters.



Source: *Western Harbour Crossing*, A commemorative publication for the Nishimatsu Kumagai Joint Venture, 1996

3.1.4 Pulling together

The ability of the promoters to convince the Government of their capability of risk retenton depends heavily on the establishment of a strong consortium. It is imperative that experienced financial and technical consultants and other investors are brought in to the group to evaluate and share the risks. The best consortism is one which is able to share such risks through its experience and expertise, as demonstrated by its past track record.

The Western Harbour Tunnel Company (WHTC) was then formed, allowing the construction contractors to withdraw as investors. Once formed, it was up to the Tunnel Company to organise the Shareholder's Agreement, finalise the design and construct contract, formulate the Tunnel Operation and Management Organisation and to set up a Consultants Agreement to coordinate independent checking of the construction works. The contractors were then able to concentrate on the design and construct contract awarded by the newly formed tunnel company to the Nishimatsu Kumagai Joint Venture (NKJV).

Formed for the financing and construction of the new tunnel, the Western Harbour Tunnel Company (WHTC), entered into a design-construct contract with NKJV who, in turn, entered into a design agreement with the MAPB Joint Venture, comprising Maunell consultants Asia, Ltd, Acer Consultants (Far East) Ltd and Parsons Brinckethoff (Asia) Ltd.

The Joint Venture then appointed a number of subconsultants for specific areasof the contract including Architect, RMJM for the design of the two ventilation buildings, the administration buildings, a small south control building and input on the toll plaza area. Landscape subconsultant is Clouston International and specialist traffic planner MVA is involved in the toll collection system.

Source: *Western Harbour Crossing*, A commemorative publication for the Nishimatsu Kumagai Joint Venture, 1996

3.1.5 The ventilation and administration buildings

RMJM Hong Kong Ltd was appointed as a sub consultant to the main designers to study the preliminary designs for the buildings and ancillary structures. These included the administration and ventilation building and a small satellite control building on Hong Kong Island.

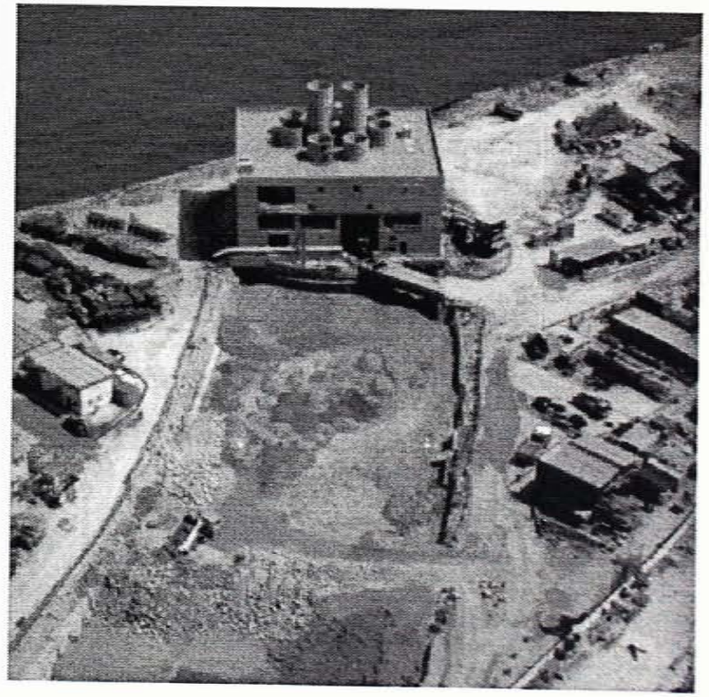
The shape of the administration building, was as is usual on most toll highway projects, and the site suited the building. The most important aspect of the layout is the orientation of the control room and the view of the toll plaza and associated facilities. Training rooms above the control also overlook the toll plaza area and are intended to provide a working illustration to aid training purposes.

The building has been designed with a definite hierarchy, with the prominent rooms sited at either end. The ground floor features main reception areas, general amenity and recreation rooms, as well as 'back of house' functions such as workshops and plant rooms. The first floor incorporates staff changing areas, and areas for the operations manager, the electronic E&M room plus training and briefing rooms. The top floor houses senior administration staff, administration support staff, a computing area and a dedicated computer room. The air conditioning and water supply and plant and equipment are set back and consealed on the roof in an attractive 'top hat' arrangement.

Ventilation buildings

The construction includes a massive supply plenum which wraps around the whole of the mezzanine floor of both floors, providing an air intake through the wall at ground level. The exhaust shafts run from ground level all the way through the building exiting at varying heights with a minimum of 5 m above any outlet or louvre. Damper control adjustments are carried out within the shaft itself and the exhausts are finished with chimney caps and mitred louvres to interface with those at lower levels.

Ventilation and administration building at Kowloon side



Ventilation building at HK Island side

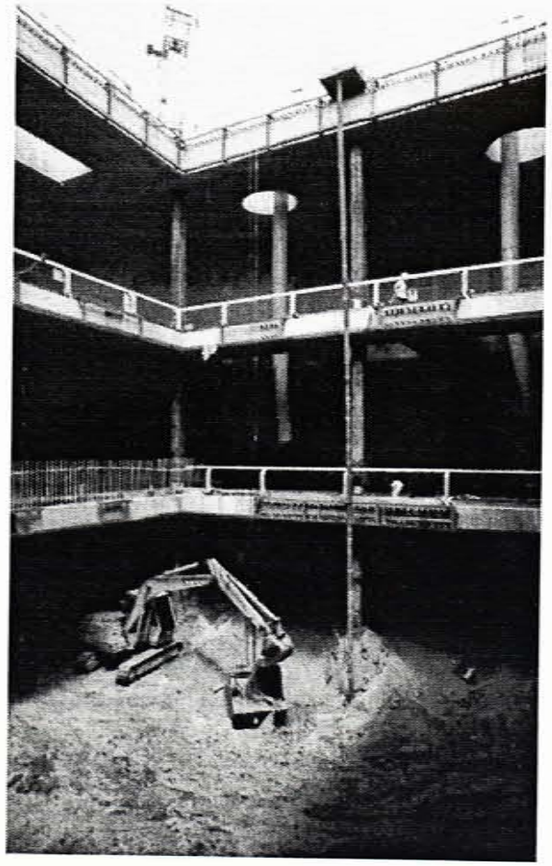
Source: *Western Harbour Crossing*, A commemorative publication for the Nishimatsu Kumagai Joint Venture, 1996

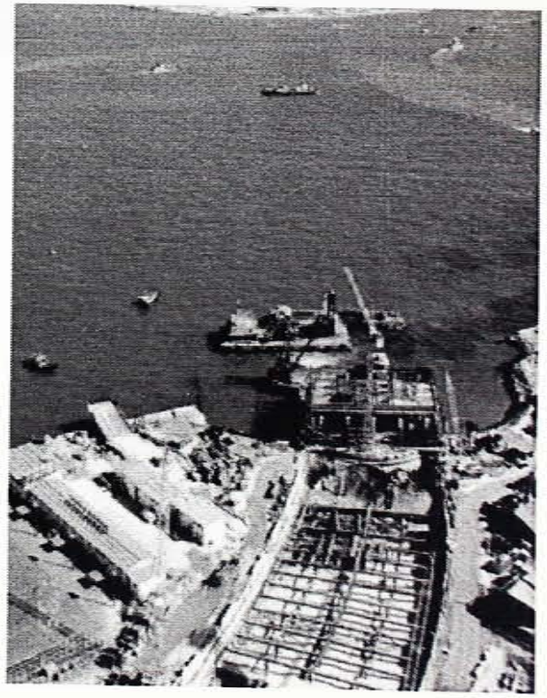
3.1.6 Ventilation shafts and buildings construction

The contiguous piled cofferdams have a 19 m radius and will support the ventilation building's superstructure in which will be housed dampers and silencers for the intake and exhaust fans and electrical and mechanical equipment. The circular shaft is 38 m in diameter formed by 1.2 m thick diaphragm panels and excavated to a depth of 68 m in reclaimed marine sand, overlaying alluvial deposits, resting on decomposed granite formations. Withinthe ring, barrettes were formed and concrete up to the level where the base slab was to be cast. From this point, the two shafts and the buildings superstructure was completed using the 'Top Down' technique.

The base of the shaft at road level consisted of a 2.5 m thick slab of heavily reinforced concrete. With the completion of the road slab, the horizontal spine wall and infill slabs were completed from the bottom of the shaft to ground level. Water level was controlled during construction by using deep wells within the excavation, with pumping only stopping once the structure had sufficient weight to resist the uplift forces. A two-storey reinforced concrete superstructure with air exhaust chimneys on the roof completes the building. Around the building, steel coated panelshang from a steel structure forming a baffle wall.

Both ventilation structures included eleven barrette foundations, some with king Posts to act as temporary supports for the internal wall slab. Each of the ventilation buildings is connected to the immersed tube section by a short stub tunnel, which in turn will act as the bearing support to the end of the first immersed tube tunnel unit.





Construction of ventilation shafts and buildings

Source: *Western Harbour Crossing*, A commemorative publication for the Nishimatsu Kumagai Joint Venture, 1996

3.1.7 Immersed tube tunnel construction

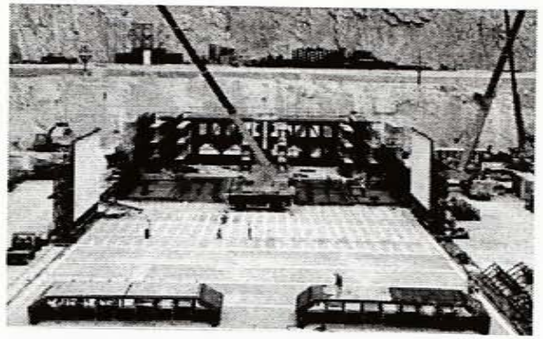
The central section of the project comprised an immersed tube tunnel with a total length of 1,363 m. This is made up of 12 pre-cast tunnel sections, each weighting around 35,000 t. The sections were pre-cast in a specially constructed basin at Shek O Quarry on the southern side of Hong Kong Island. The agreement by the Hong Kong Government to allow provate, single-point moorings to be established at Junk Bay meant that the units did not have far to travel to the temporay storage area.

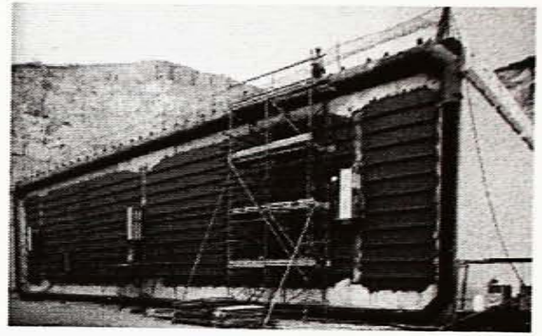
The casting basin was formed by excavating granite rock to -10m PD and much of the excavated material was subsequentiy used in the concrete mix for the casting of the tunnel sections. One of the casting basin had been excavated to the required depth, the casting of the immersed tube units could commence. These units, each 113m x 33.5m x 8.5m were cast in 16.5m bays with the bases and wall starters formed by the first pour.

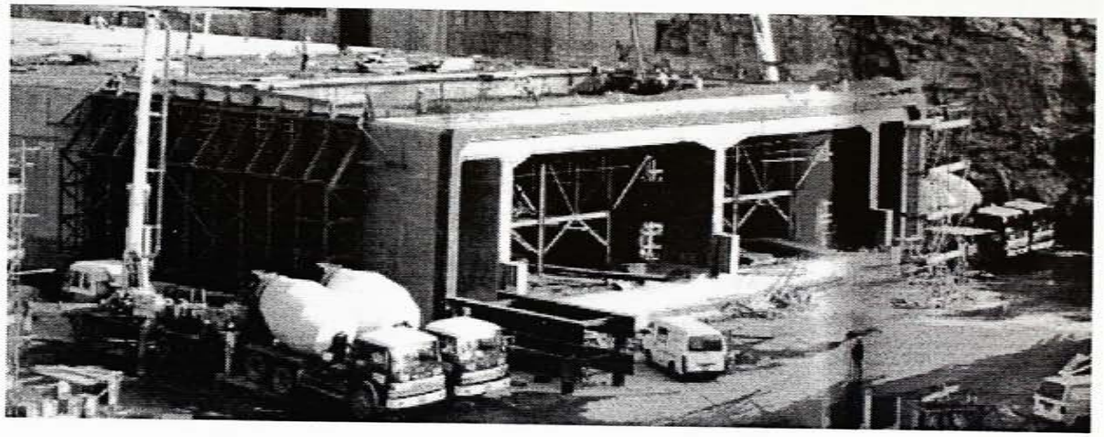
There were four sets of sliding forms, all working on one section at a time and the concrete cycle time per bay was nine days. The external walls and roof of each tube section are coated with a waterproof membrane and the roof is protected by concrete fenders and covered with a thin layer of concrete.

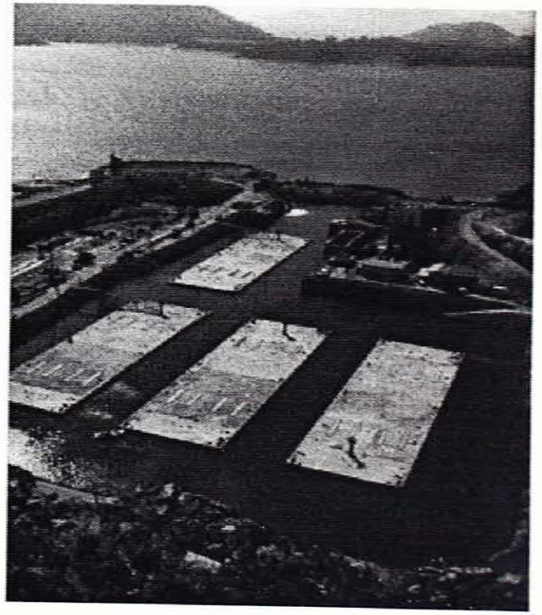
When construction of immersed tube tunnel units had been completed, the internal ballast were filled with water to prevent flotation. The basin was then flooded by pumping in sea water. The temporary cofferdam constructed to allow the exit channel to be formed was then removed by dredger. The ballast water was gradually pumped out so that the units floated up and achieved the required freeboard before the units were towed to the temporary mooring area.

The casting basin was dewatered by pumping and construction of the second batch of units commenced. The 45,000 m^2 quarry basin took over five days to fill at a rate of 270 m^3 per hour to its full depth of 11m.









Construction of immersed tube tunnel

Source: *Western Harbour Crossing*, A commemorative publication for the Nishimatsu Kumagai Joint Venture, 1996

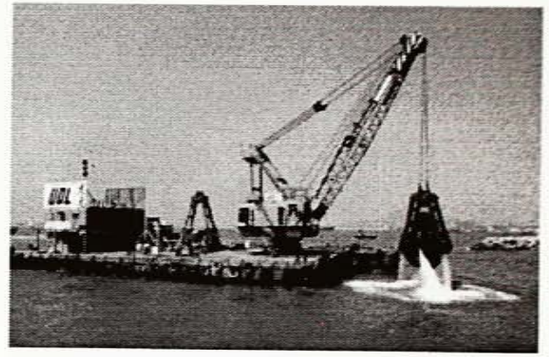
3.1.8 Lowering & positioning[1]

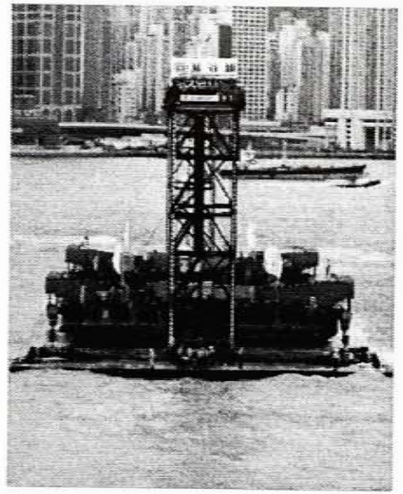
Whilst the tunnel sections are in the holding area at Junk Bay, all the necessary control towers, lowering pontoons and winches were fitted, which will be used in the lowering process. Well before each section left the holding area, a trench in the sea bed was excavated to the required level including any removal of unsuitable material and replacement with sand fill. Bulk dredging was carried out to provide a trench to within one metre of the required depth before trimming to achieve the required profile.

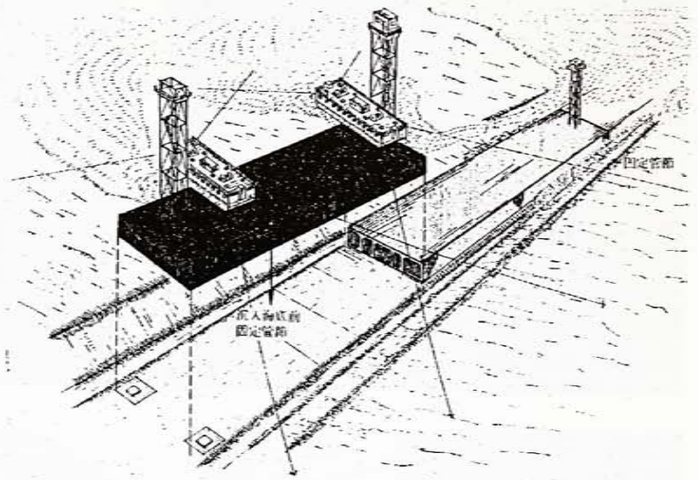
All the units, fitted with two survey towers, had two winch pontoons sited on the roof, attached by special winch cables. WAter was pumped into the internal ballast tanks to make the units negatively buoyant and to transfer the load onto the pontoons. Controlled sinking was achieved by ballasting the unit with around 1,200 t of sea water. The actual lowering operation which took from 8-16 hours was carried out in incremental steps with the process being continuously monitored from the control towers.

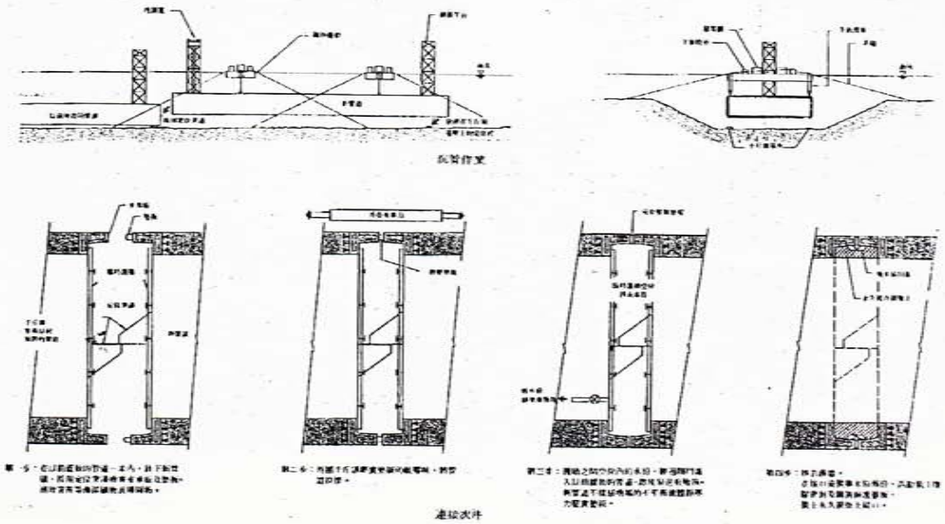
In total more than 990,000 m³ of material was dredged for the 1,362 m long trench. The base of the trench was approximately 40 m wide and 10-15 m deep with a 1:2 slope produced to the trench sides. The main shipping fairway was actually moved three times during the operation with the dredging and trimming being carried out in three stages.

Once the units were in position and the sand placing was complete, selected locking fill, comprising a pure sand mix, was pumped around the lower edges of the walls of the immersed tube units. General backfill, comprising completely decomposed granite was placed above this. Above the general fill a rock blanket of approximately 250 mm in diameter was placed and a 500 kg armoured was placed and a 500 kg armoured rock Anchor Release Band was positioned either side of the tube unit.









Delivery by sea, lowering & positioning of the immersed tube tunnel unit[2]

Source:
[1]*Western Harbour Crossing*, A commemorative publication for the Nishimatsu Kumagai Joint Venture, 1996
[2]Building for the Future, The New HK Tunnel Co. Ltd., 1987

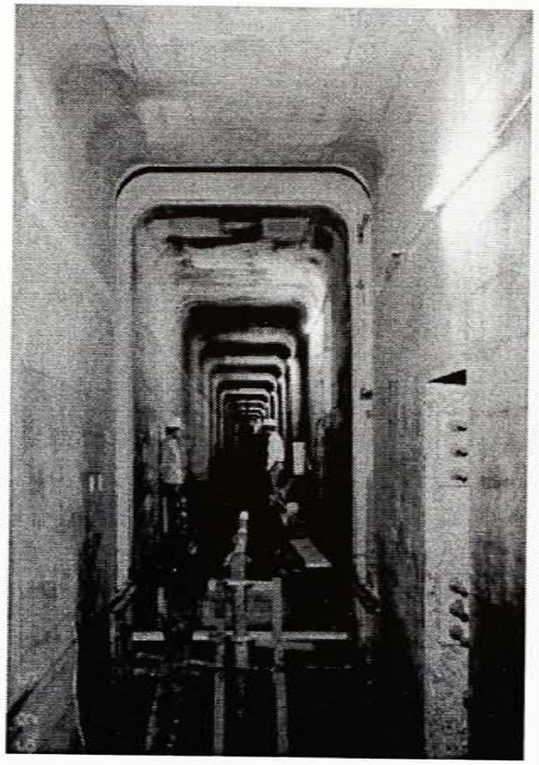
3.2 BUILDING SYSTEMS & SERVICES OF UNDERWATER TUNNEL

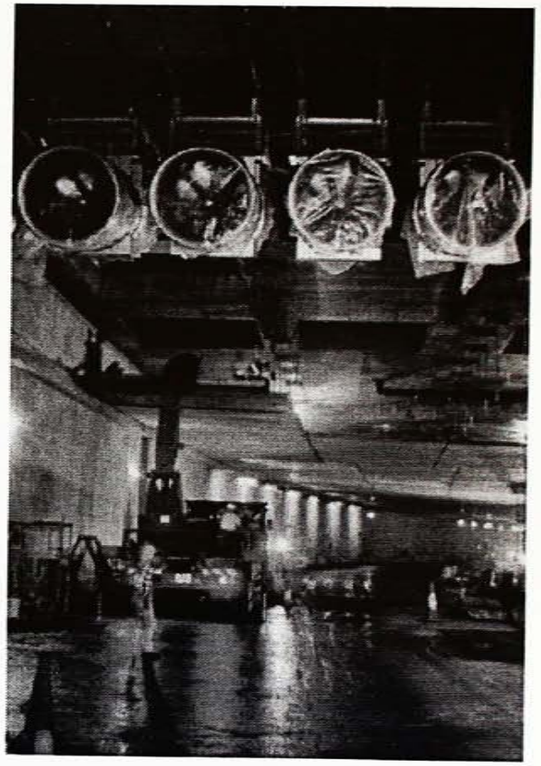
3.2.1 Ventilation system (Western Harbour Crossing)

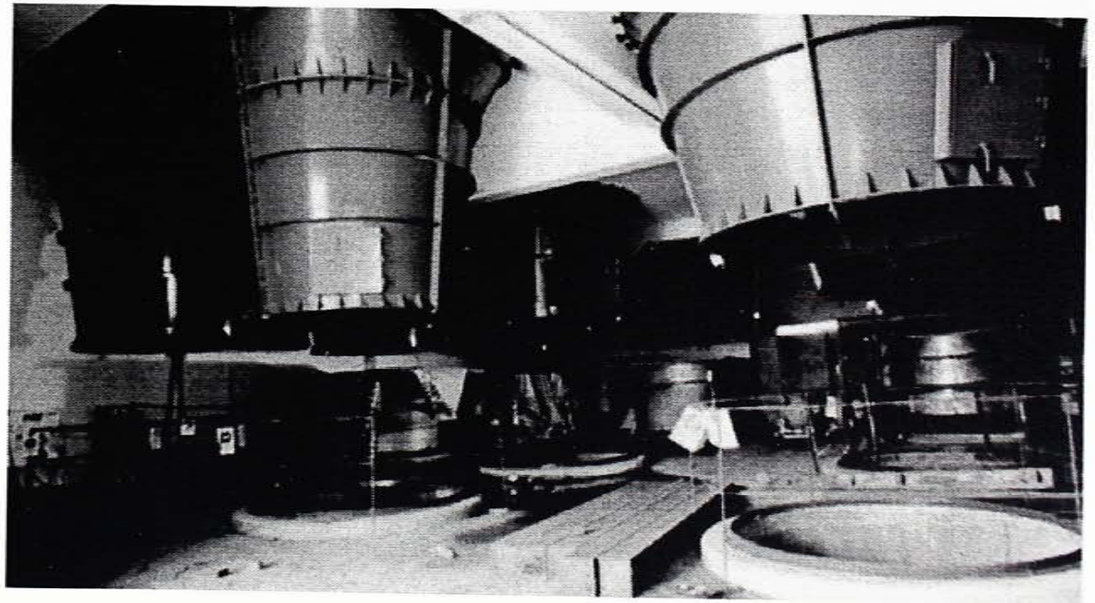
The tunnel ventilation system together with the CMCS has been designed to monitor tunnel air quality and utilise mechanical ventilation to limit the concentration of emissions to acceptable levels; monitor and maintain visibility within the tunnel at acceptable levels; control the spread of smoke and extract the smoke to provide a smoke-free path not less than 2 m high above the road surface for evacuation of passengers and an access for fire fighting personnel.

A semi-transverse supply ventilation system has been adopted for the immersed tube section with side air ducts. A fully transverse ventilation scheme was implemented at the cut and cover section at both ends, connected to ceiling ducts. Both ventilation buildings each house 18 reversible ventilation fans capable of operating at 250°C amibent air temperature for one hour and delivering 90% air volume in reverse flow direction. Fresh air is supplied from eacg building to the adjacent cut and cover tunnels and half of the immersed tube sections, To assist smoke control during uni-directional traffic operation, five jet fans have been provided underneath the ventilation building.

The fresh air intakes and exhaust discharge shafts have been fitted with noise attenuating equipment to limit the noise levels from fan operation in the areas around the ventilation buildings.







Service tunnel and tunnel ventilation system

Source: *Western Harbour Crossing*, A commemorative publication for the Nishimatsu Kumagai Joint Venture, 1996

3.2.2 Types of ventilation systems

Depending on the manner in which fresh air is injected and vitiated air is exhausted, tunnel ventilation systems can be classified into one of the following types:

1. Natural ventilation, where fresh air is drawn in from one tunnel portal and vitiated air is expelled out of the other portal via the piston effect of moving vechicles;

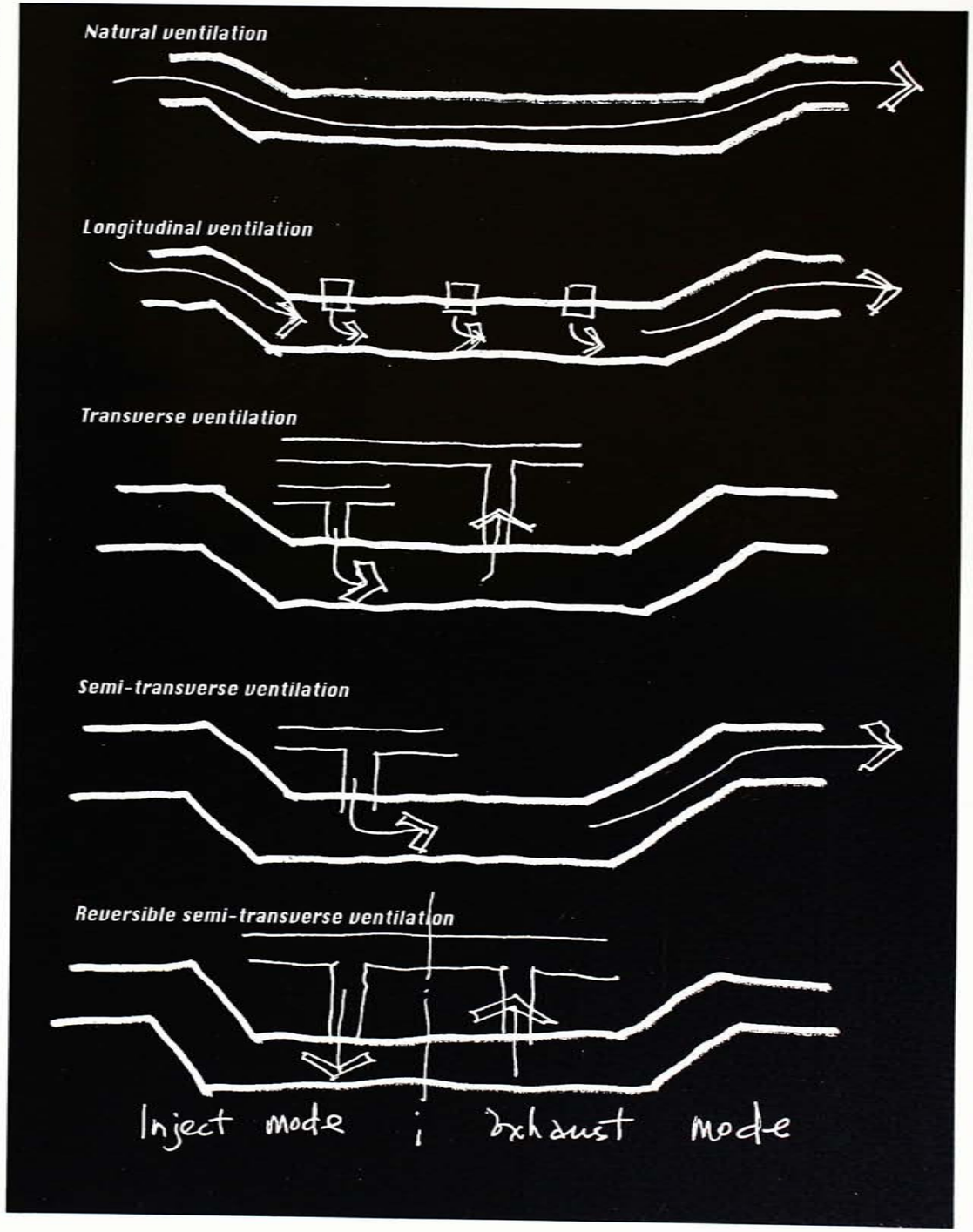
2. Longitudinal ventilation, where fresh air is drawn in from one tunnel portal and vitiated air is expelled out of the other portal via tunnel longitudinal air velocities introduced artificially;

3. Transverse ventilation, where fresh air is injected and vitiated air is exhausted through separate perforated ducts installed along the tunnel tube;

4. Semi-transverse ventilation, where fresh air is injected through a perforated duct installed along the tunnel tube and vitiated air is exhausted through the tunnel portals;

5. Reversible semi-transverse ventilation, where fresh air is injected through a perforated duct installed along the tunnel tube, with provision for exhaustion of vitiated air through the same duct when operated in reverse mode;

6. variations embodying a combination of the above types.

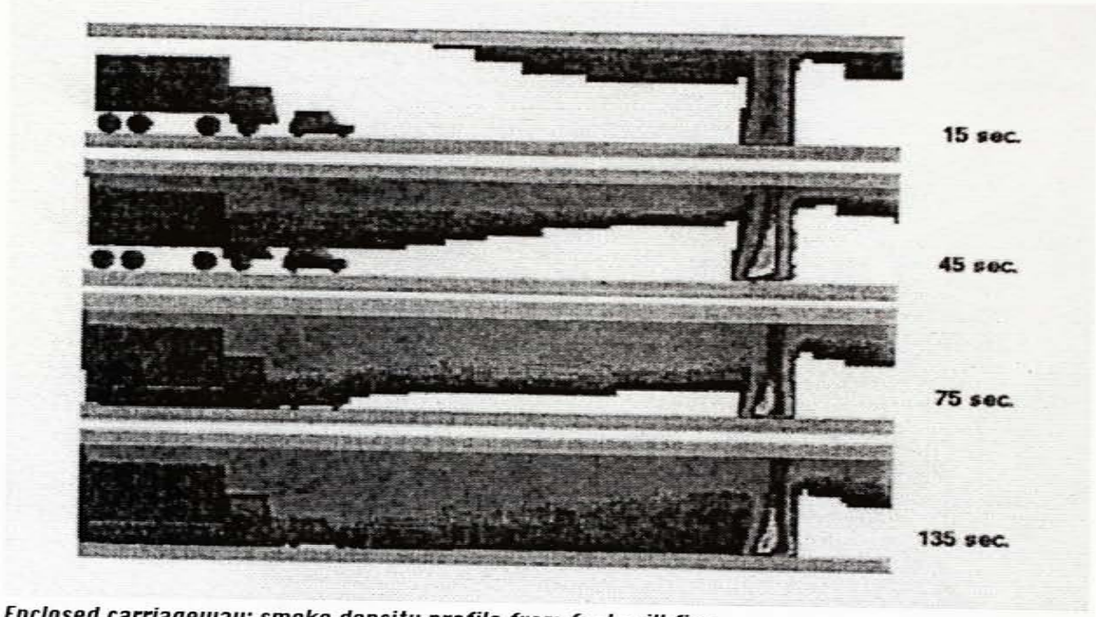


Types of ventilation systems

Source: Transport Planning & Design Manual, Transport dept, HK, Vol. 11

3.2.3 Smoke & fire behaviour simulation (Kap Shui Mun Bridge)

Computer simulation studies of the Kap Shui Mun Bridge so as to predict smoke and fire behaviour. This study was undertaken in the UK by Roger Preston & Partners in conjunction with the Fire Research Station, part of the Building Research Establishment. The two major hazards considered were smoke and high temperatures. In the simulation, traffic upstream of the fire was assumed to be trapped while those downstream of the fire source had a clear escape route. The purpose of the simulation was to determine whether the specified jet fans were capable of forcing smoke downstream away from trapped vehicles and also to determine the extent to which visibility would be limited. Temperature increase was examined in order to estimate the exacuation time. The final optimised design used jet fans to keep visibility within the acceptable limits and generally transport the combustion products in the desired direction.



Enclosed carriageway: smoke density profile from fuel spill fire

3.2.4 Fire protection (Western Harbour Crossing)

The fire protection system for the tunnel incorporates hydrants and hosereels together with detection and alarm systems. Two sections of the city main have been re-routed to the two ventilation buildings and these will preserve the fire hydrant/hosereel system. Each ventilation building is equipped with two sets of fire pumps, a jockey pump and one 36 m^3 F.S. tank.

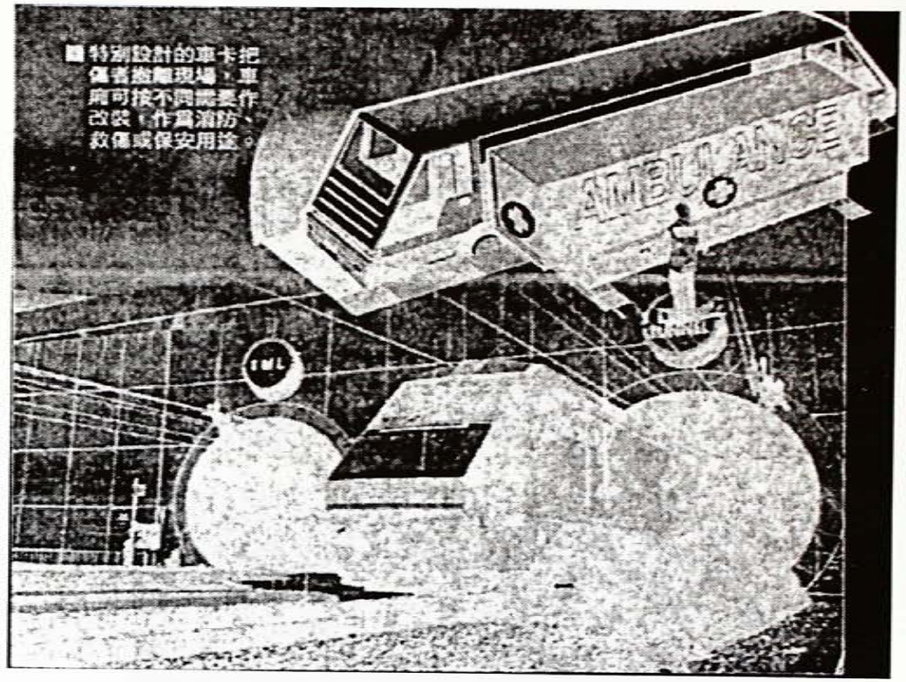
The fire mains within the tunnel have been extended to serve the hydrants on the ground level roads at the Sai Ying Pun portal, the toll plaza and the administration building area. A manual break glass alarm call points are located at intervals of approximately 50 m. Activation of any of these call points initiates remote audible and visual warnings at the control console of the administration building.

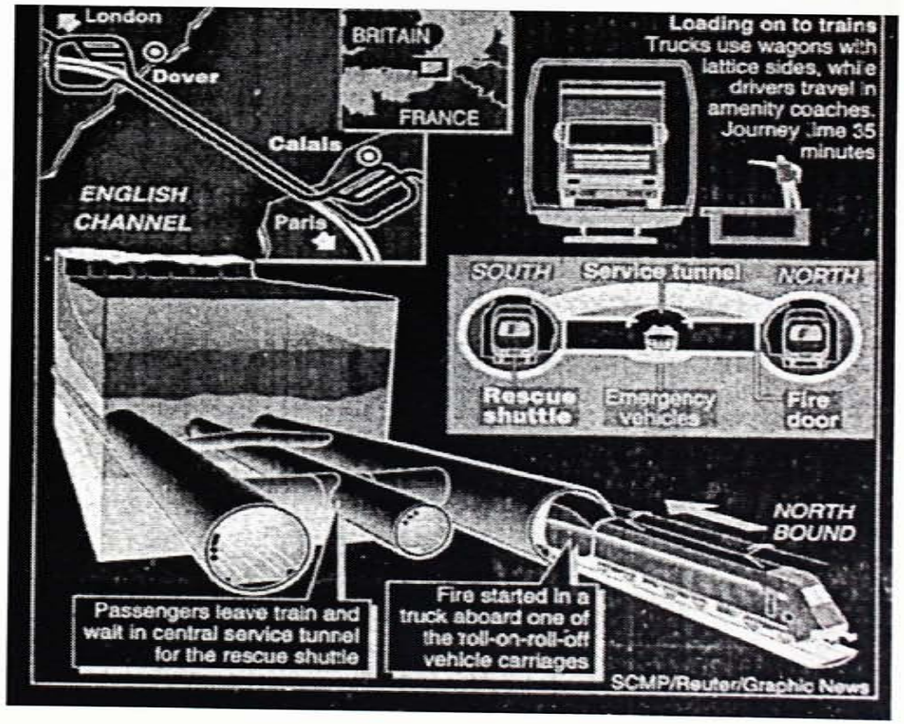
Source: *Western Harbour Crossing*, A commemorative publication for the Nishimatsu Kumagai Joint Venture, 1996

3.2.5 Emergency and services tunnel (Channel Tunnel)

The service tunnel house all E & M systems and services of the Channel Tunnel. In case of accidents happened inside the tunnel, the services tunnel can be served as emergency access for people to move to another safety place within a short time. In the Channel Tunnel, the two rail tunnels have located exit doors along every 50 m and connected to the services tunnel.

The service tunnel not only served as emergency access but also emergency vehicle can pass through and can serve the whole tunnel in case of different kinds of accidents. The emergency vehicle is specially design and can suit for different purpose. The body of the vehicle is empty and can store a container-liked cubic. There are different cubics like ambulance, fire-fighting and so on. The above method was used in the fire accident happened in 18-11-1996 inside the Channel Tunnel.



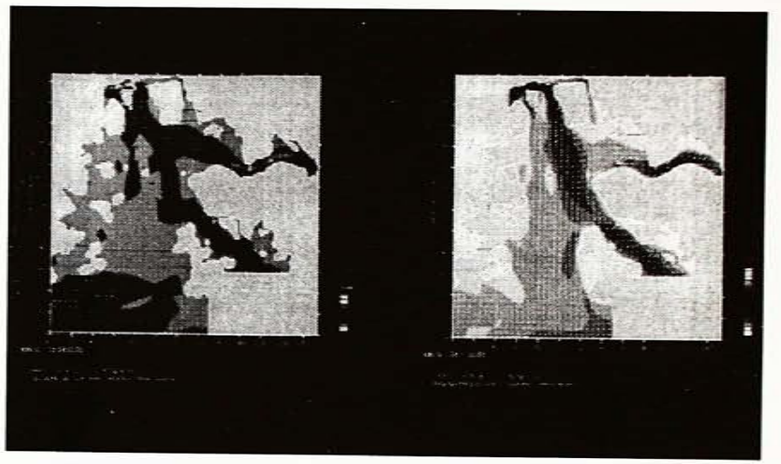


Source:
Ming Poe, 18-11-1996
South China Morning Post, 18-11-1996

3.3 ENVIRONMENTAL IMPACTS & ISSUES

3.3.1 Hydrological conditions

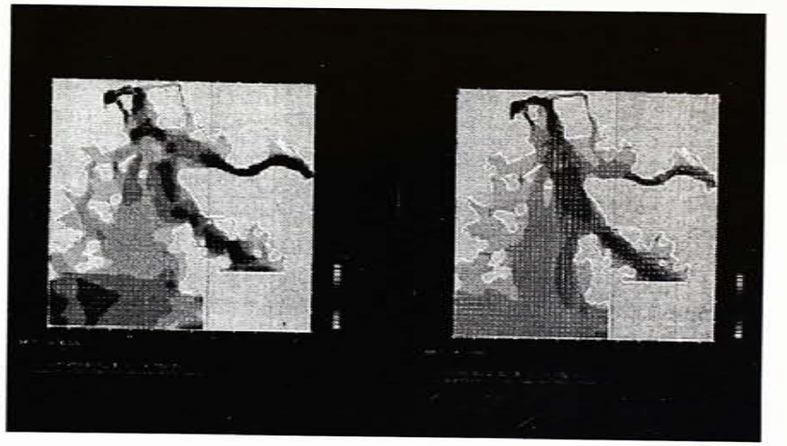
The main marine activities take place in the Victoria Harbour and increasingly in the western harbour. Victoria Harbour is well sheltered from swells by Hong Kong Island and has been the focus of port operations in Hong Kong. It is surrounded by high-density urban development and recieves largely untreated sewage, discharged through a number of outfalls. The western harbour is an open fetch of water to the west of Hong Kong Island and Lamma Island. It is exposed to swells from the south and is used mainly as a ship anchorage. The average depth of water is 10 metres in Victoria Harbour and 8 metres in the western harbour. The average tidal velocity inside the Victoria Harbour is 6 metres/second. The fastest record is 12 metres/second.



Tidal current in 1990

3.3.2 Sedimentation rate

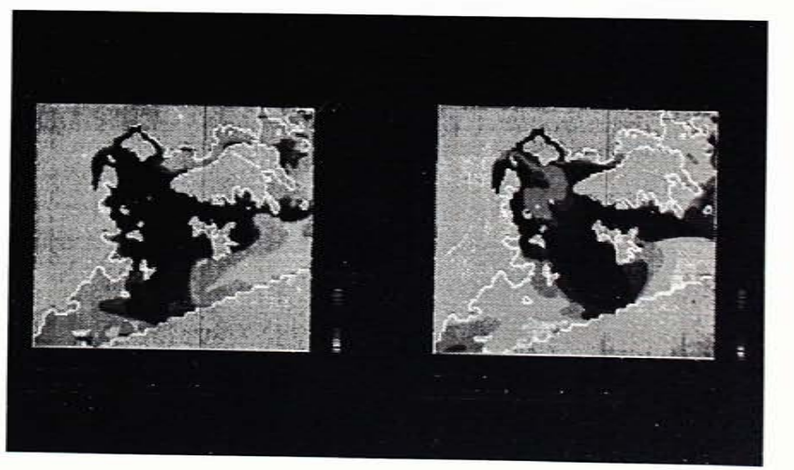
Victoria Harbour is well propected by Hong Kong Island from swells. On the other hands, siltation in Victoria Harbour is mainly from the suspended material in the Peal River flow. However, sediments carried in the stormwater flows discharged at outfalls around the harbour also contribute to siltation. The average sedimentation rate in Victoria Harbour from such sources is 20mm/year.



Predicted tidal current after completion of TDS recamations

3.3.3 Hydraulic studies

In recent years ,Government has put forward a major port development programme and a number of large scale reclamations for providing land for urban growth. To ensure that the harbour hydraulic conditions at any stages of these projects will suit the waterborne activities, thorough hydraulic studies have been carried out. Modelling studies of the three reclamations in Victoria Harbour show that, upon completion of the reclamation projects, the peak current velocity between Central and TST would reduce by 12%. Those in other areas would basically remain unchanged. Besides, the siltation rate in Victoria Harbour and the western harbour would actually decrease by 10% and 20% respectively.



Predicted mud concentration after completion of TDS reclamations

Source: The shape of things to come, Planning, Environment and Lands Branch, Hong Kong Government, Sept 1995

3.3.4 Summary statistics of 1994 water quality of Victoria Harbour

Temperature (°C)	Surface	23.8 (17.7 - 28.1)	23.7 (17.7 - 28.1)
	Bottom	23.2 (17.6 - 27.3)	23.1 (17.5 - 27.3)
Salinity (ppt)	Surface	30.5 (24.6 - 33.0)	30.4 (24.5 - 33.0)
	Bottom	31.6 (27.8 - 33.1)	32.1 (30.9 - 33.5)
D.O. (% saturation)	Surface	79 (57 - 109)	86 (70 - 115)
	Bottom	66 (49 - 101)	81 (60 - 123)
pH		8.1 (7.9 - 8.3)	8.1 (8.0 - 8.3)
Secchi disc depth (m)		1.5 (1.0 - 3.1)	1.6 (0.9 - 2.9)
Turbidity (NTU)		6.8 (3.9 - 12.2)	8.4 (2.4 - 24.2)
Suspended solids (mg/L)		9.1 (2.1 - 13.3)	8.4 (1.6 - 22.0)
Silica (as SiO_2) (mg/L)		1.1 (0.4 - 2.5)	1.2 (0.3 - 2.4)
BOD_5 (mg/L)		0.8 (0.4 - 2.6)	0.6 (0.3 - 1.6)
Nitrite Nitrogen (mg/L)		0.03 (0.01 - 0.07)	0.03 (0.01 - 0.07)
Nitrate Nitrogen (mg/L)		0.12 (0.05 - 0.27)	0.12 (0.05 - 0.27)
Ammoniacal Nitrogen (mg/L)		0.25 (0.03 - 0.43)	0.16 (0.03 - 0.38)
Total Inorganic Nitrogen (mg/L)		0.39 (0.23 - 0.53)	0.32 (0.16 - 0.46)
Total Nitrogen (mg/L)		0.73 (0.43 - 1.17)	0.62 (0.41 - 1.08)
Orthophosphate (mg/L)		0.05 (0.02 - 0.07)	0.04 (0.01 - 0.06)
Total Phosphorus (mg/L)		0.09 (0.05 - 0.14)	0.08 (0.03 - 0.09)
Phaeo-pigment (μg/L)		1.39 (0.20 - 6.77)	1.28 (0.27 - 3.30)
Chlorophyll - *a* (μg/L)		2.88 (0.20 - 21.33)	2.70 (0.20 - 16.30)
E. coli (No./100mL)		1979 (543 - 14200)	622 (88 - 11400)
Faecal Coliform (No./100mL)		2809 (630 - 16700)	857 (103 - 12733)

Note : 1. Except as specified, data presented are depth-averaged data.
2. Data presented are annual arithmetic means except for *E. coli* and Faecal Coliform data which are geometric means.
3. Data enclosed in brackets indicate the ranges.

Summary statistics of 1994 water quality of Victotia Harbour West

Temperature (°C)	Surface	23.6 (17.6 - 27.6)	23.6 (17.7 - 27.9)	23.6 (17.7 - 27.9)
	Bottom	23.1 (17.5 - 27.4)	23.1 (17.6 - 27.5)	23.1 (17.6 - 27.4)
Salinity (ppt)	Surface	30.9 (25.6 - 33.0)	30.6 (25.1 - 33.0)	30.7 (25.1 - 33.0)
	Bottom	31.9 (29.1 - 33.5)	31.9 (30.1 - 33.4)	31.9 (30.4 - 33.1)
D.O. (% saturation)	Surface	75 (39 - 108)	73 (45 - 104)	76 (62 - 104)
	Bottom	64 (38 - 100)	60 (40 - 95)	61 (47- 95)
pH		8.1 (7.8 - 8.3)	8.0 (7.8 - 8.2)	8.0 (7.9 - 8.2)
Secchi disc depth (m)		1.8 (1.2 - 2.5)	1.7 (1.0 - 3.2)	1.5 (1.0 - 2.5)
Turbidity (NTU)		5.2 (2.7 - 10.2)	5.3 (2.5 - 9.1)	5.6 (3.4 - 9.6)
Suspended solids (mg/L)		6.4 (2.4 - 12.6)	6.7 (2.3 - 13.7)	7.5 (3.6 - 14.3)
Silica (as SiO_2) (mg/L)		1.0 (0.1 - 2.2)	1.1 (0.2 - 2.2)	1.1 (0.4 - 2.2)
BOD_5 (mg/L)		0.9 (0.4 - 1.7)	1.0 (0.5 - 1.8)	0.9 (0.4 - 2.5)
Nitrite Nitrogen (mg/L)		0.03 (0.01 - 0.06)	0.03 (0.01 - 0.07)	0.03 (0.01 - 0.06)
Nitrate Nitrogen (mg/L)		0.10 (0.03 - 0.20)	0.11 (0.04 - 0.25)	0.11 (0.05 - 0.23)
Ammoniacal Nitrogen (mg/L)		0.28 (0.07 - 0.45)	0.30 (0.09 - 0.49)	0.29 (0.03 - 0.48)
Total Inorganic Nitrogen (mg/L)		0.40 (0.21 - 0.57)	0.44 (0.22 - 0.57)	0.43 (0.24 - 0.58)
Total Nitrogen (mg/L)		0.75 (0.50 - 1.29)	0.80 (0.53 - 1.21)	0.79 (0.47 - 1.29)
Orthophosphate (mg/L)		0.05 (0.02 - 0.08)	0.05 (0.02 - 0.08)	0.05 (0.03 - 0.08)
Total Phosphorus (mg/L)		0.11 (0.04 - 0.24)	0.11 (0.04 - 0.21)	0.10 (0.06 - 0.20)
Phaeo-pigment (μg/L)		1.53 (0.02 - 9.57)	1.18 (0.30 - 4.93)	1.09 (0.20 - 5.13)
Chlorophyll - *a* (μg/L)		3.29 (0.27 - 23.67)	2.87 (0.20 - 17.23)	3.01 (0.23 - 23.00)
E. coli (No./100mL)		7562 (2833 - 48000)	6875 (1133 - 27667)	4020 (867 - 19333)
Faecal Coliform (No./100mL)		10502 (4400 - 69333)	10161 (1500 - 41000)	5812 (1333 - 24667)

Note : 1. Except as specified, data presented are depth-averaged data.
2. Data presented are annual arithmetic means except for *E. coli* and Faecal Coliform data which are geometric means.
3. Data enclosed in brackets indicate the ranges.

Summary statistics of 1994 water quality of Victoria Harbour Central

Temperature (°C)	Surface	23.5 (17.6 - 27.7)	23.6 (17.6 - 27.9)
	Bottom	22.6 (17.2 - 27.5)	22.8 (17.5 - 27.6)
Salinity (ppt)	Surface	31.2 (26.0 - 33.6)	31.0 (25.6 - 33.2)
	Bottom	32.7 (30.9 - 34.2)	32.4 (30.7 - 34.1)
D.O. (% saturation)	Surface	78 (55 - 106)	77 (41 - 118)
	Bottom	70 (51 - 105)	66 (53 - 103)
pH		8.1 (8.0 - 8.3)	8.1 (8.0 - 8.3)
Secchi disc depth (m)		1.8 (1.0 - 2.5)	1.6 (1.2 - 2.2)
Turbidity (NTU)		5.0 (2.4 - 11.1)	5.8 (2.7 - 21.4)
Suspended solids (mg/L)		6.7 (2.8 - 11.7)	6.9 (3.3 - 14.2)
Silica (as SiO_2) (mg/L)		0.9 (0.3 - 1.2)	0.9 (0.1 - 1.6)
BOD_5 (mg/L)		0.7 (0.3 - 1.1)	0.9 (0.4 - 1.7)
Nitrite Nitrogen (mg/L)		0.02 (<0.01 - 0.05)	0.03 (0.01 - 0.06)
Nitrate Nitrogen (mg/L)		0.08 (0.03 - 0.15)	0.09 (0.03 - 0.19)
Ammoniacal Nitrogen (mg/L)		0.22 (0.09 - 0.43)	0.26 (0.13 - 0.47)
Total Inorganic Nitrogen (mg/L)		0.32 (0.14 - 0.49)	0.38 (0.20 - 0.56)
Total Nitrogen (mg/L)		0.71 (0.40 - 1.06)	0.76 (0.55 - 1.23)
Orthophosphate (mg/L)		0.04 (0.02 - 0.07)	0.05 (0.02 - 0.07)
Total Phosphorus (mg/L)		0.10 (0.04 - 0.15)	0.10 (0.03 - 0.22)
Phaeo-pigment (μg//L)		0.81 (0.23 - 3.00)	0.92 (0.20 - 3.97)
Chlorophyll - *a* (μg//L)		2.04 (0.30 - 10.60)	2.85 (0.27 - 18.80)
E. coli (No./100mL)		8911 (1467 - 30667)	12409 (5367 - 210667)
Faecal Coliform (No./100mL)		11155 (1867 - 32667)	16844 (8000 - 282000)

Note : 1. Except as specified, data presented are depth-averaged data.
2. Data presented are annual arithmetic means except for *E. coli* and Faecal Coliform data which are geometric means.
3. Data enclosed in brackets indicate the ranges.

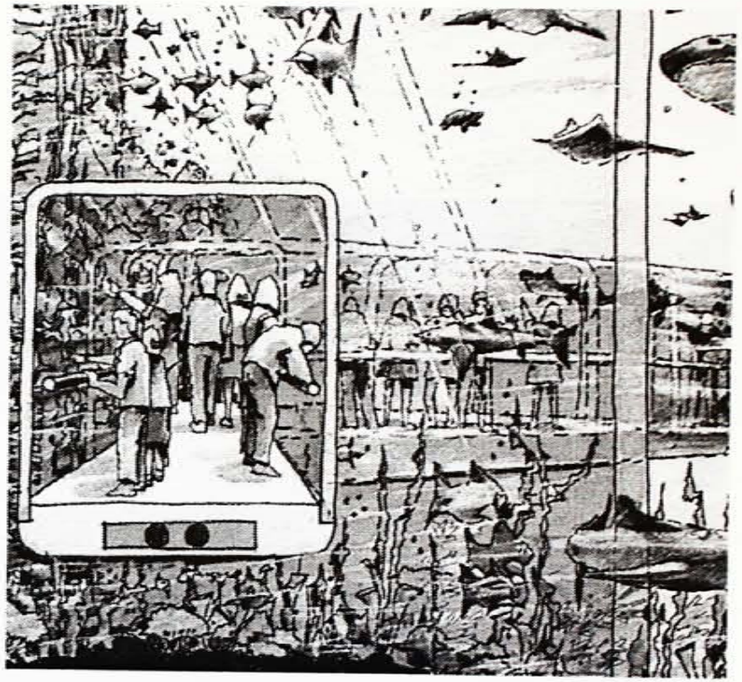
Summary statistics of 1994 water quality of Victoria Harbour East

Source: Marine Water Quality in HK for 1994 - Monitoring Section, Water Policy & Planning Group, Environmental Protection Dept. HK Government 1995

3.4 IMAGES OF UNDERWATER (PSYCHOLOGICAL & PHYSIOLOGICAL) COMPARE TO UNDERGROUND ENVIRONMENT

Image of underwater (psychological & physiological) compare to undergroung environment

	Physical nature	Psychological feeling	Physiological feeling	Technical problems
Underwater environment	1. Translucent 2. Transparency 3. Dynamic because of wave 4. High resistant because of water pressure	1. Silent 2. Everything enclose to you 3. Excitement 4. Pass through different media from land to water	1. Feeling close in terms of hearing 2. High water pressure 3. Decrease in daylight when getting deeper	1. Ventilation 2. Means of escape 3. Lighting 4. Fire services
Underground environment	1. Dark 2. Cold 3. Massive in nature 4. Stale air 5. Primitive	1. Afraid 2. Dangerous 3. Dead 4. Enclosing by massive rock	1. no sense of direction 2. Cold	1. Ventilation 2. Means of escape 3. Lighting 4. Fire services



Underwater image

Underground image

CHAPTER 4 CASE STUDIES

4.1 HONG KONG CASE STUDIES

4.1.1 Underground Carpark, Shopping Complex and Walkway System between the New World Center and the Space Museum[1]

The proposed development lot was originally intended to be developed by the Urban Council as a 2 storey partly sunken car park for 250 vehicles to serve the Cultural Center, with an area of open space provided on top of the structure. Zoned as open space on the Outline Zoning Plan, the New World Development Company proposal consisted of constructing an underground car park and shopping area, together with a pedestrian walkway system connecting to the adjacent New World Center (at basement level) and beneath Salisbury Road next to the Peninsula, and the construction of a public park for the Urban Council connected to the Tsim Sha Tsui harbour promenade.

In May 1988, the Government agreed to rezone the site for 'Other Specified Uses' annotated on the plan as 'public open space' with 'underground commercial complex and car park'.

A detailed consultancy study was prepared by the Applicant, to examine the key planning, transportation, environmental, enfineering and lands issues, associated with the scheme. The Town Planning Board subsequently approved the proposal as it was considered to be compatible with Government's development intentions for the area, and offered substantial planning gain. The folowing conditions were stipulated in the approval:

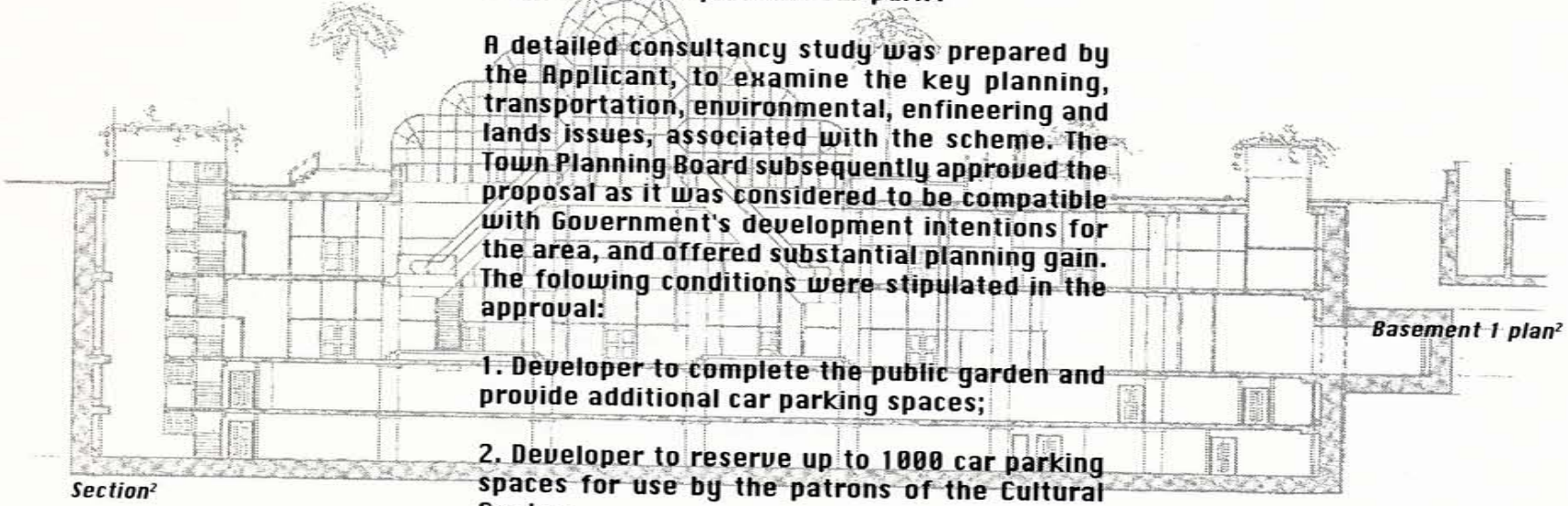
1. Developer to complete the public garden and provide additional car parking spaces;

2. Developer to reserve up to 1000 car parking spaces for use by the patrons of the Cultural Center;

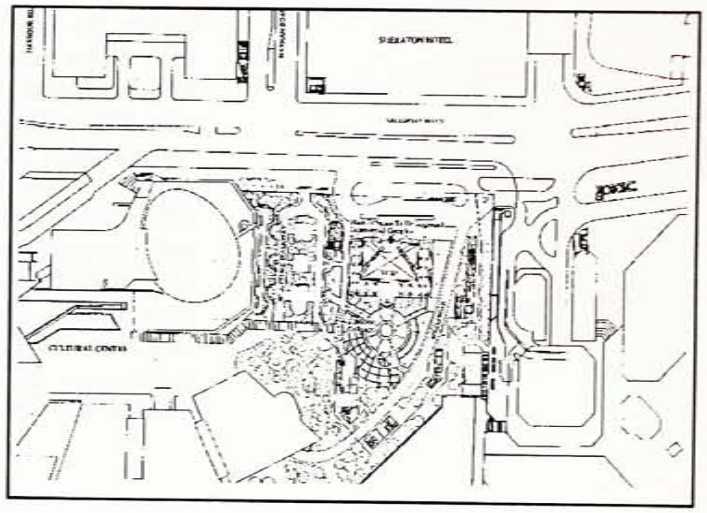
3. Traffic access to the car park would be via the New World Center;

4. Developer to provide free of cost to government, two pedestrian subways;

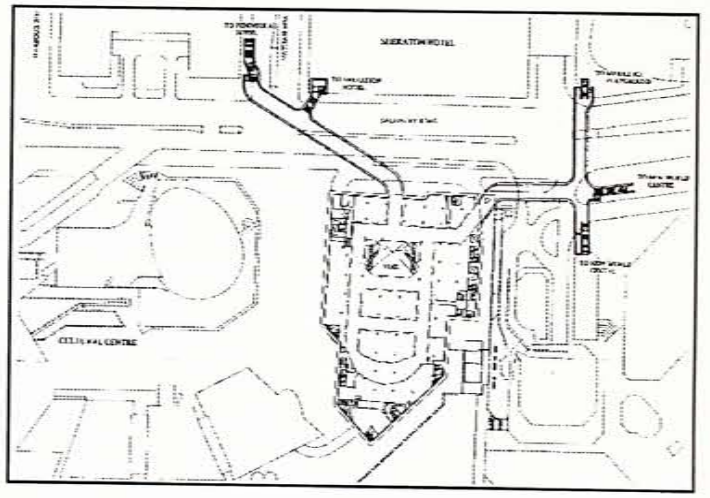
5. Developer to provide the garden free of cost to government



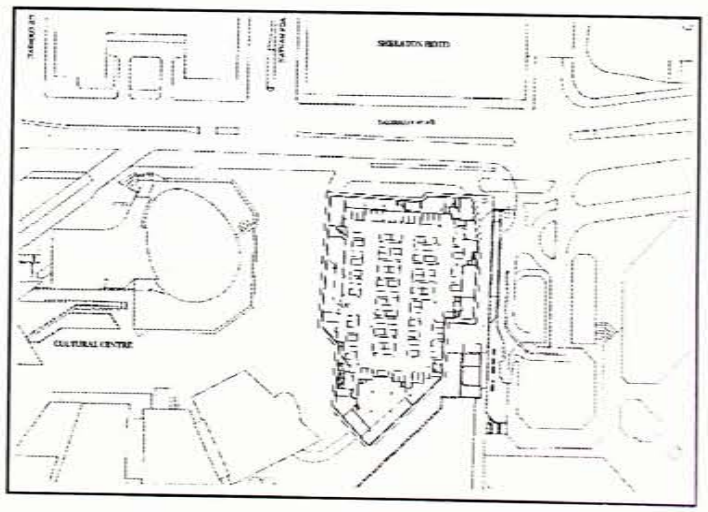
Section[2]



Ground floor plan[2]



Basement 1 plan[2]



Basement 3 plan[2]

Source:
[1]Planning Study on Underground Development of Commercial Facilities Extending Beyond Private Land, Final Report, Planning Dept, HK, 1991
[2]Schematic design drawing of underground development at Salisbury Garden, Kwan & Associates Ltd.

4.1.2 Underground Car Park and Shopping Complex beneath Salisbury Road, Tsim Sha Tsui, between the Peninsula Hotel and the Cultural Center

Hong kong Shanghai Hotels, submitted a planning application for a 4-level underground shoping and carparking scheme together with a pedestrian link beneath Salisbury Road, in April 1989. Zoned primarily 'Road' and partly 'Other Specified Uses', the above ground site comprises 4,460 m².

The first planning application was rejected by the Town Planning Board on the grounds that the proposed commercial and car parking elements were considered to be excessive and that the potential disruption to road traffic during the construction period needed to be fully assessed.

The Town Planning Board advised the applicant to:

1. Reduce the retail element of the scheme to the minimum, to maintain viability;

2. Extend the pedestrian links by connecting them with both the MTR station and the Salisbury Garden development;

3. Reduce the number of car parking spaces and confine their use to the development only;

4. Submit a traffic impact study report indicating the transportation impacts of the development during construction and the measures required to maintain satisfactory traffic flows in adjoining roads during the construction period.

The developer subsequently submitted a technical report to assess planning, transportation and technical viability aspects of the proposal, which was approved by the Town Planning Board in March 1990.

The scheme will comprise 13,399m² of retail development on two levels together with 125 car parking spaces on the lower 2 levels of the scheme. The developer will allocate 50 car parking spaces for the sole use of the Urban Council. The car parking areas of the underground scheme will have access from the Urban Council site at the Cultural Center. The scheme will provide significant planning gain to the public, with pedestrian linkages to the MTR station and beneath Salisbury Road, to the Cultural Center, Space Museum and Salisbury Garden developments adjacent to the Tsim Sha Tsui waterfront.

Source: Planning Study on Underground Development of Commercial Facilities Extending Beyond Private Land, Final Report, Planning Dept, HK, 1991

4.2 OVERSEAS CASE STUDIES

4.2.1 Kawaski Underground Development

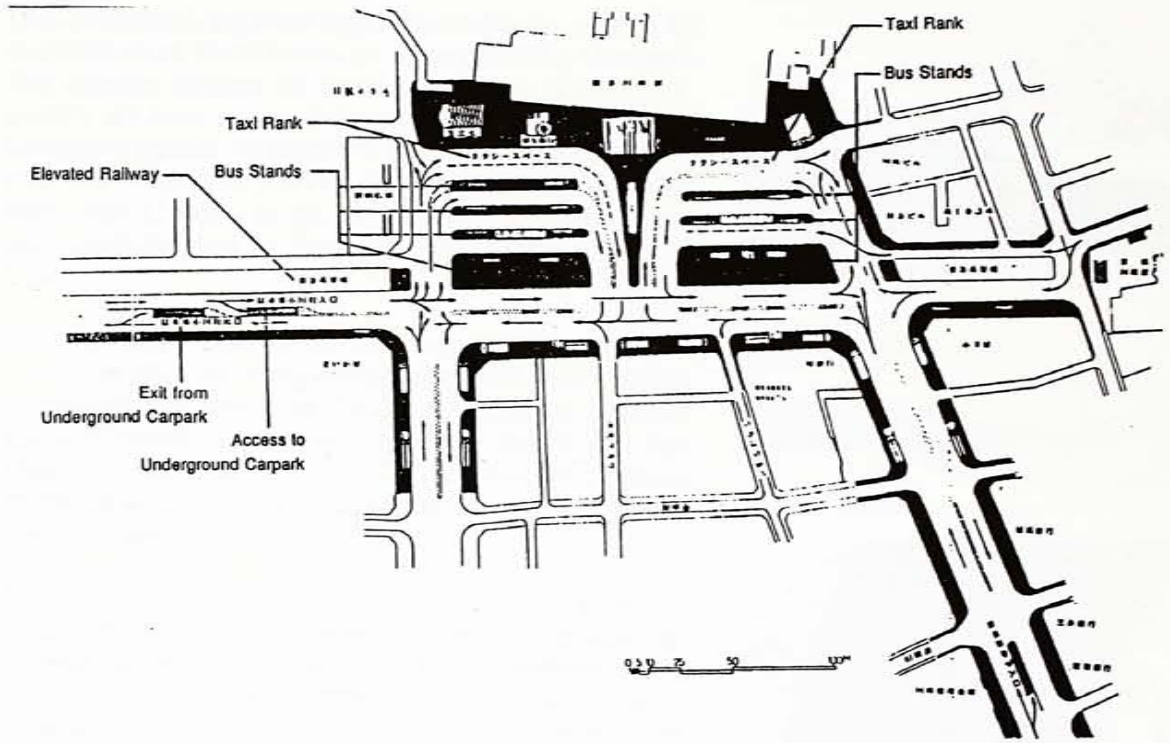
Constructed in 1986 the underground scheme at Kawaski was financed by private developers looking to enhance the attractiveness of their adjacent retail outlets in the vicinity of the station by providing an underground retail and car parking facility which would complement existing retail provision and be financially self-supporting.

The underground scheme was constructed simultaneously with the remodelling of the Kawaski main line station and the project also included the provision of an improved bus terminals which was reinstated above the underground scheme.

The internal layout of the shopping mall illustrates a pattern of retail provision which is based upon a rectilinear grid, with a strong central pedestrian axis located beneath a skylight which brings natural light into the scheme. Pedestrian movement throughout the scheme is concentrated along major corridors, to maximise retail floorspace utilisation.

There is a considerable variety in the size of retail units in the scheme and a tenancy mix of about 23% to 75% engaged in selling convenience and durable goods respectively. The occupancy rate is currently over 90%.

The scheme is designed to maximise pedestrian accessibility to neighbouring land uses. There are over 34 points of entry to the scheme; the majority providing pedestrian access to the above ground bus stands and to neighbouring department stores at basement level.



Ground floor plan

Basement plan

Source: Planning Study on Underground Development of Commercial Facilities Extending Beyond Private Land, Final Report, Planning Dept, HK, 1991

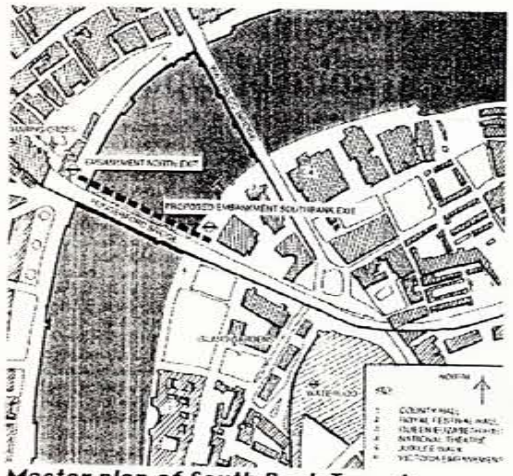
4.2.2 South Bank Tunnel

The most notable aspect of the successful South Bank Competition entry by Richard Rogers was his clearly stated objective to double the number of people who visit the South Bank. This is to be achieved by a varety of measures including 'strengthening and unifying' the area, achieving the 'correct balance of uses and activities to create (sufficient) critical mass' and creating a 'comfortable environment all year round'.

The proposal was designed to 'refocus the heart of London', and it is here that Rogers reveals the essential weakness of the South Bank as a cultural venue. It is separated, both in perception and in practical terms, from the cultural and commercial heart of London. This is firstly because of the river, and secondly because of the South Bank's location outside the central underground transport system, which is clearly defined by the Circle Line.

Of London Underground's 266 stations, all but 26 are on the north side of the Thames, and of the 14 mainline stations, only two are south of the river. This transport infrastructure perpetuates the focus of activity north of the river, and it is against this focus that the South Bank struggles.

The competition brief had called for a plan that achieves 'the best possible relationship of the arts buildings, to each other within the core site and in relation to the wider area.' By developing a strategy to double the number of visitors, improving the facilities and creating a temperate environment within his new 'Crystal Palace', rogers has done what is necessary to achieve both 'critical mass' and an attractive environment. However, the location remains divorced from the 'hub' of London, and the stated intention to 're-focus the heart of London' and to make the South Bank 'an integral part of the center of London' has yet to be achieved.



Master plan of South Bank Tunnel

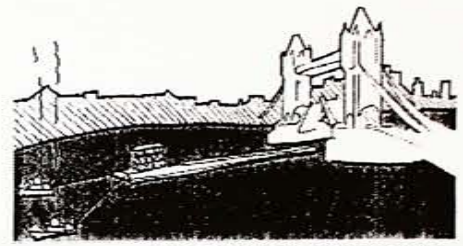
Source: The Architect's Journal, 30-11-1995

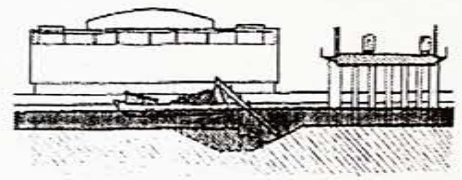
This proposal, by Paul Hyett Architects, seeks to resolve that final issue of accessibility through the simple device of connecting the 'core site' south of the river directly into the 'hub' of London's public-transport system. Embankment station - on the Circle, District, Bakerloo and Northern Lines - is given an exit to South Bank adjacent to and in Front of the Royal Festival Hall.

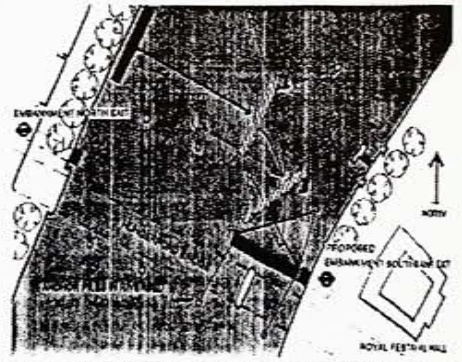
For the first time in its history, the South Bank complex will be truly accessible and effectively incorporated into the heart of London. Rather than attempting to refocus the heart of the capital, this proposal facilitates the easy incorporation of the South Bank into the existing cultural and commercial 'hub'.

The initiative recognises the essential accessibility issues are convenience, simplicity, safety, security, and 'door to door' journey time. For most people, travel to the South Bank complex will be by the Underground, and demands on this service will be intensified subdtantially if the Rogers proposal to double visitor numbers is achieved. In fact, the system will need to carry 12 million as opposed to the current six million visitors per annum to the South Bank complex.

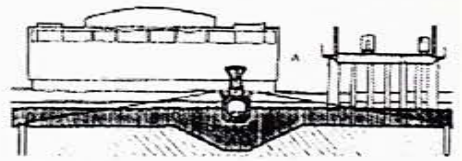
It is proposed to construct the Embankment station South Bank exit tunnel by the immersed-tube method, as recently used for the Medway road tunnel. This would have the dual benefits of being a shallow tunnel and cheaper than a deeper, bored tunnel.

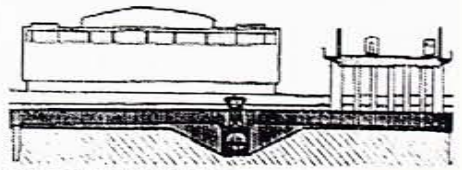

THREE TUNNEL SECTIONS FORMED IN DRY DOCK, FITTED WITH TEMPORARY CONTROL TOWERS AND TOWED UPSTREAM TO THE SITE

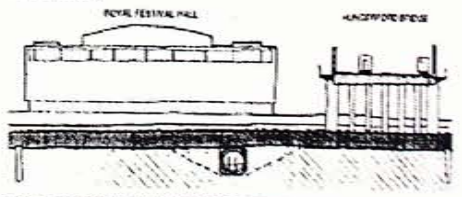

RIVERBED CHANNEL DREDGED IN PREPARATION FOR TUNNEL SUBMERSION



TUNNEL SECTIONS MOORED TO NORTH BANK AND WINCHED INTO POSITION IN SEQUENCE


TUNNEL SECTIONS MOORED INTO POSITION READY FOR SUBMERSION


TUNNEL SECTIONS SUBMERGED AND CONNECTED TO PREVIOUS SECTION. CONTROL TOWER REMOVED



RIVERBED REINSTATED, TUNNEL SECTIONS CONNECTED, DRAINED AND FITTED OUT

CHAPTER 5 PROJECT BRIEF

5.1 Client profile

5.2 Programs development

5.3 Inter-relationship of programs structure

5.4 Individual program components

5.1 CLIENT PROFILE

5.1.1 Client profile

As the proposed underwater pedestrian harbour crossing is not a realistic project and no pecedent before in Hong Kong or even in the whole world, client of the project is supposed to be a hypothetical one.

Take the Western Harbour Crossing as the most similar reference, the client of the proposed pedestrian harbour crossing will be a joint venture compancy set up by series clients that come from different groups like developers, contractors and public sectors.

As the proposed harbour crossing is an extremely complicated project and needs large scale of investment and technical knowledge, the selected developers, contractors and public sectors will form a joint venture company. The company will enter the local shock market and raise fund from the public.

The company will then either buy or rent the land and get the franchise of running the tunnel in certain years from the government. After that, the company will issue the contract to the selected principal contractors. The contract type, most proportly will be in the form of Build Operate and Transfer (BOT) Contract.

5.1.2 Proposed clients composition

The clients in the joint venture company will come from different aspects and mainly are developers, contractors and public sectors.

Developers

Swire - one of the major land and building owner in Central

Kowloon Stock - most of the buildings next to the site at TST are owned by Kowloon Stock

Ocean Park - as it will have an aquarium inside the development, Ocean Park have the experience in operating the aquarium

Contractors

Nishimatsu Construction Co Ltd - one of the most experiencial construction company in doing infrastructure project (especially underwater tunnel) both in Hong Kong and in the world

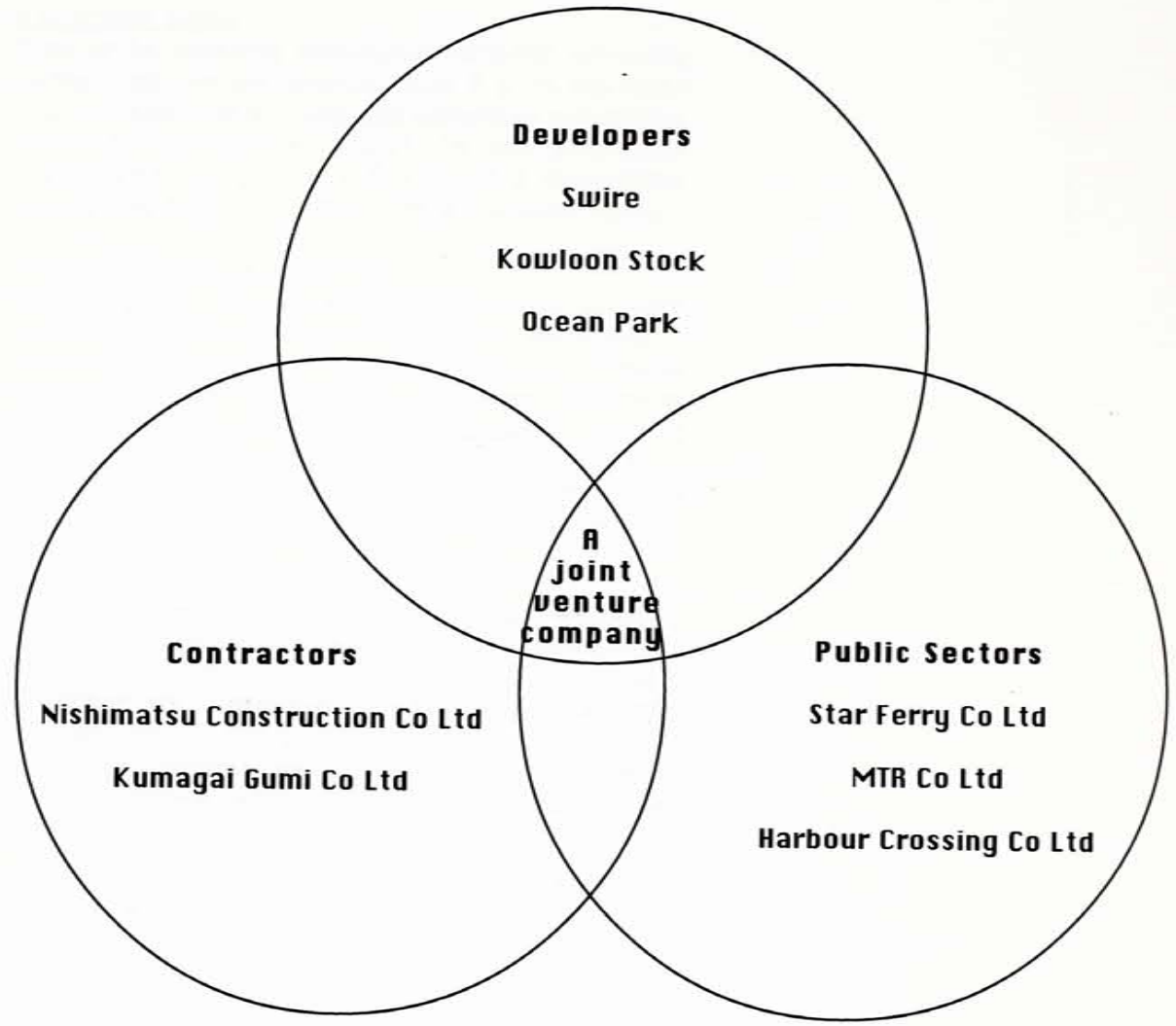
Kumagai Gumi Co Ltd - same as above

Public sectors

Star Ferry Co Ltd - the proposed harbour crossing will lad Star Ferry decrease in its profit and it is better lad Star Ferry join the company to compensate its lost

MTR Co Ltd - it will have a mass transit expressway either in the form of travelator or monorail inside the development; MTR Co Ltd have the experience in running such system and it is suitable for the company to join into

Harbour Crossing Co Ltd - the company have long experience in operate harbour crossing tunnel



Proposed client composition

5.2 PROGRAMS DEVELOPMENT

5.2.1 Programs development

1. Cross harbour link
2. Shopping street
3. Restaurant, cafe, food court
4. Aquarium, marine education center
5. Exhibition, performance space
6. Services zone
7. Administration building
8. Vent shaft building

5.2.2 Programs description

Cross harbour link
This is the major element and function of the proposed development. It will form a network to bring people from one side of hte harbour to another. Besides, all the other program components will connect to this network.

Shopping street
As the tunnel will have high pedestrian flow all the year round, it has hihg potential to develop shopping facilities inside the tunnel. The tunnel will take a linear and horizontal pattern and will form a shopping street physically and can echo to the two sides' shopping environment.

Reataurant/cafe/food court
Those facilities are another important elements in the shopping street so that the tunnel is not a pure public circulation but also a place provide enjoyment to the users.

Aquarium/marine education center
Asthis development is directly related to water and harbour, it is possible to locate an aquarium and marine education center inside it. Those facilities can be served as both entertainment and education to public which related to sea life and marine environment. Furthermore, those facilities can draw people attention and will attract people using the harbour crossing.

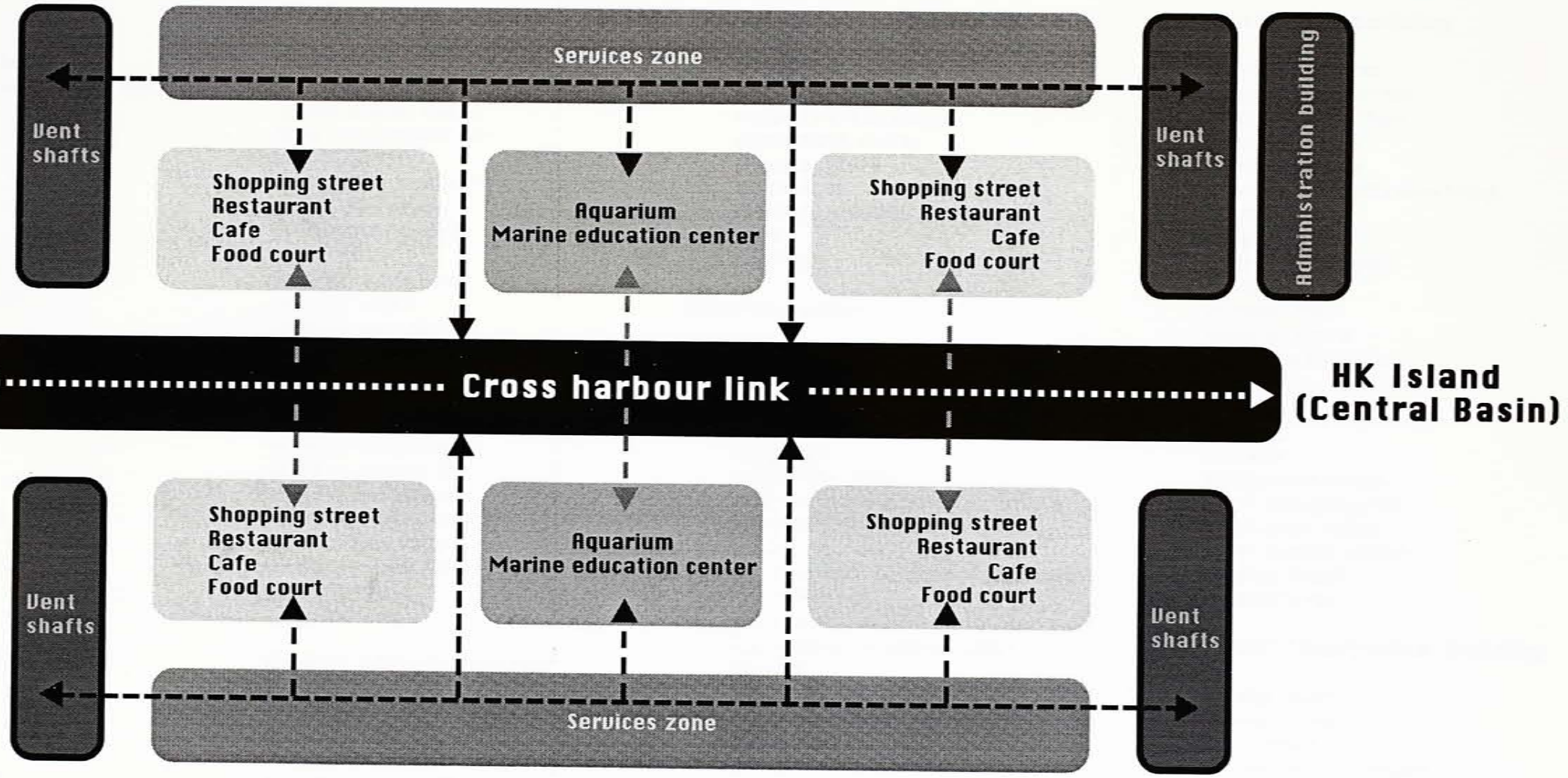
Exhibition & performance space
Both TST & Central are having important cultural facilities like Cultural Center, City Hall and so on. The proposed tunnel entrances are closed to those facilities and it is possible to provide similar functions inside the tunnel and echo to the site context.

Services zone
Similar to existing vehicular harbour crossing tunnel, all tunnel services and E & M systems are centralize in a space and served as a services zone of the whole tunnel. In the proposed harbour crossing, all A/C, F. S. and E & M systems will group together and form a services zone.

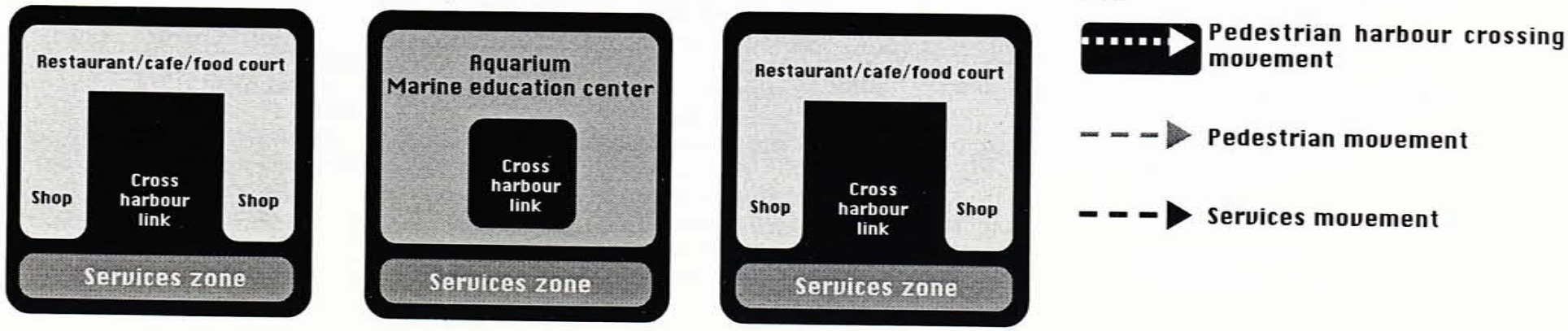
Administration building
The administration building houses all the operation machines and supportive facilities of the tunnel. Inside the building, staffs will control those machine to maintain the tunnel's normal operation. The proposed administration building will locate at HK Island side as the site is a reclamtion flat area and have adequate land provided to the building while TST cannot do that.

Vent Shaft building
Ventilation shafts are used for tunnel's ventilation, that is A/C system's air intake and return, emergency fresh air supply and smoke exhaust. All ventilation ducts will run through the whole tunnel and those ducts will group together and extrude at the end of the tunnel above ground level and form the ventilation shafts.

5.3 INTER-RELATIONSHIP OF PROGRAMS STRUCTURE



Programs organization plan



Programs organization section

5.4 INDIVIDUAL PROGRAM COMPONENTS

Cross harbour link

- monorail/travelator
- monorail/travelator control rm
- equipment store
- mechanical rm
- main control rm
- general store
- guard rm
- male staff toilet
- female staff toilet
- public male toilet
- public female toilet
- disable toilet
- cleaner's rm
- refuse rm

Shopping street

- shops
- general store
- loading/unloading
- male staff toilet
- female staff toilet
- cleaner's rm
- refuse rm

Restaurant/cafe/food court

- restaurant
- kitchen
- office
- loading/unloading
- general store
- cafe
- pantry
- food court
- seating area
- staff changing
- male toilet
- female toilet
- disable toilet
- cleaner's rm

Aquarium/marine education center

(aquarium)
- main water tank
- theme water tanks
- tank mechanical rm
- auditorium
- auditorium support
- exhibition space
- exhibition support
- workshop
- general equipment store
- general store
- compressor rm
- administration office
- meeting rm
- reception/information
- shop
- loading/unloading
- staff changing rm
- staff male toilet
- staff female toilet
- public male toilet
- public female toilet
- disable toilet
- cleaner's rm

(marine education center)
- lecture rm
- classroom
- meeting rm
- exhibition space
- exhibition suport
- general store
- equipment store
- workshop
- research lab
- research lab support
- staff male toilet
- staff female toilet
- public male toilet
- public female toilet
- disable toilet
- cleaner's rm

Exhibition/performance space

- exhibition space
- performance space
- support area/stage
- equipment store
- general store
- workshop
- loading/unloading
- cafe
- pantry

Services zone

- escape route
- loading/unloading
- general store
- equipment store
- cargo lift
- cargo lift lobby
- service staircases
- general control rm
- guard rm
- f.s. services/fireman control rm
- a/c plant rm
- a/c supply/return air/water duct
- f.s. supply/return air duct
- fan rm
- f.s. pump rm
- f.s. water tank
- pump rm
- water tank
- telecommunication rm
- gas duct
- fuel tank
- emergency generator rm
- transformer rm
- staff male toilet
- staff female toilet
- disable toilet
- cleaner's rm
- refuse rm
- refuse store
- loading/unloading platform
- account rm
- check rm

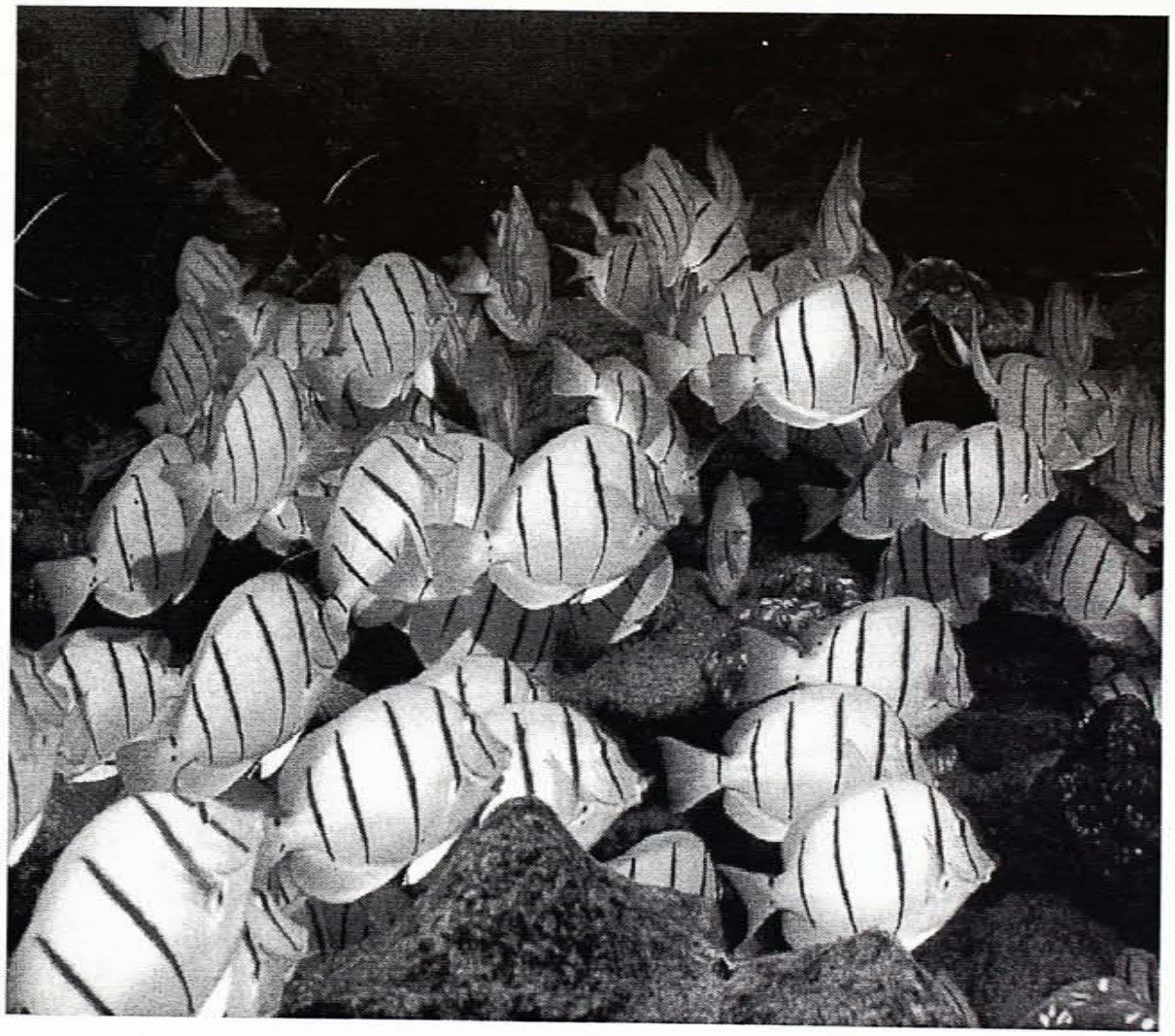
Administration building

- main control rm
- support control rm
- senior staff office
- general office
- conference rm
- briefing rm/shift musteing
- meeting rm
- computer rm
- computer support
- reception
- account rm
- general store
- entrance lobby
- reception
- recreation
- dinning
- kitchen
- equipment store
- staff changing rm
- staff male toilet
- staff female toilet
- disable toilet
- cleaner's rm

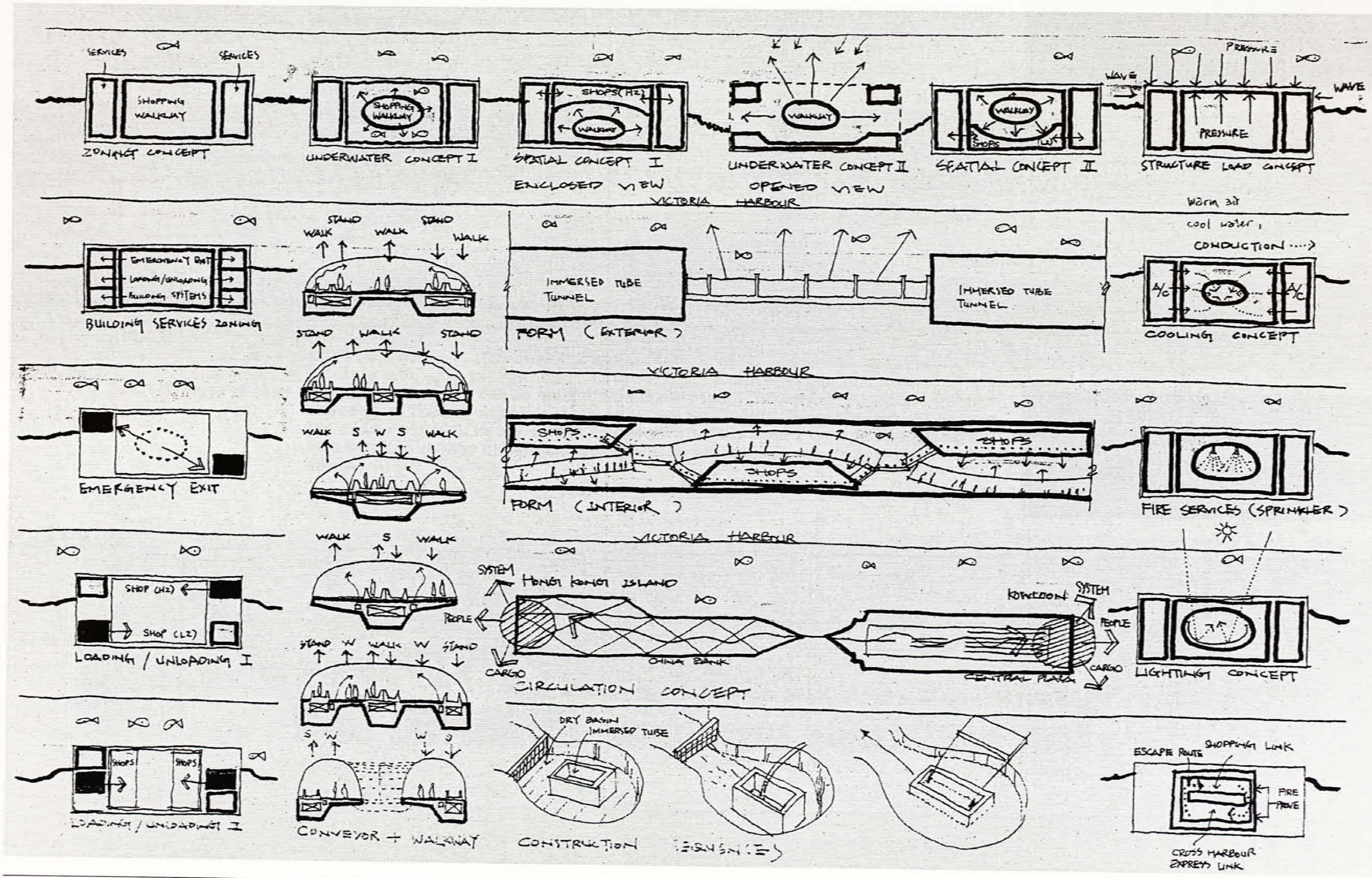
Vent Shaft/mechanical building

- supply shaft
- exhaust shaft
- air plenum
- motor control center
- HV/LV switchgear
- transformer rm
- emergency generator rm
- compressor rm
- fuel tank
- CLP rm
- f.s. water tank/ pump rm
- water tank/pump rm
- battery rm
- telecom rm
- MPF rm
- a/c plant rm
- general store
- equipment store

CHAPTER 6 DESIGN DEVELOPMENT

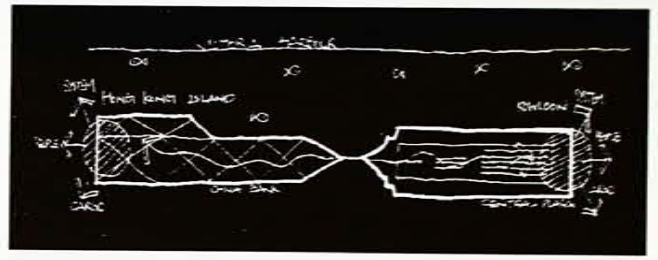


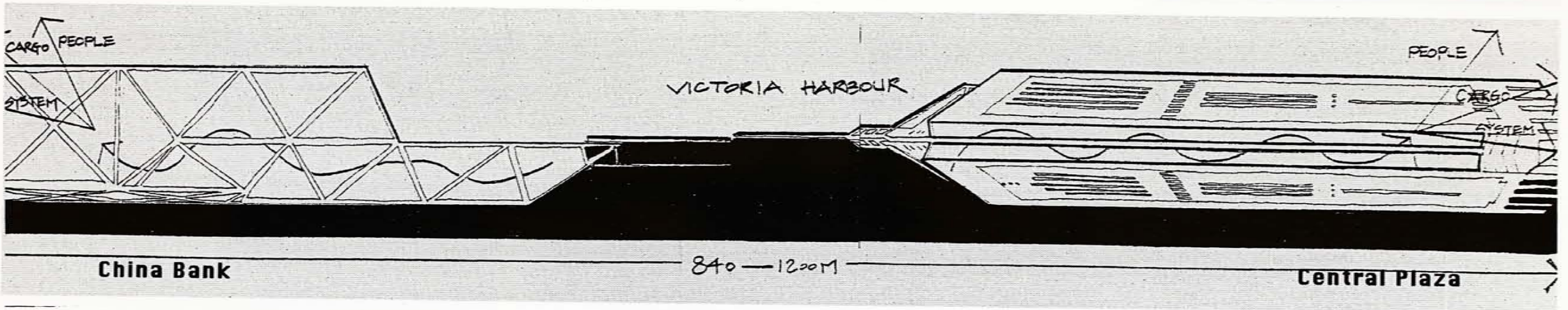
6.1 DESIGN CONCEPTS



6.1.1 Concept

The width of Victoria Harbour between TST Star Ferry Pier and Central Basin is about 1,100 m, that is the first two highest buildings in HK (Central Plaza & China Bank) 's total height. The proposed tunnel is just similar to those two highrise building's laiding down situation. All the building systems, people movement will be in horizontal pattern instead of vertical.



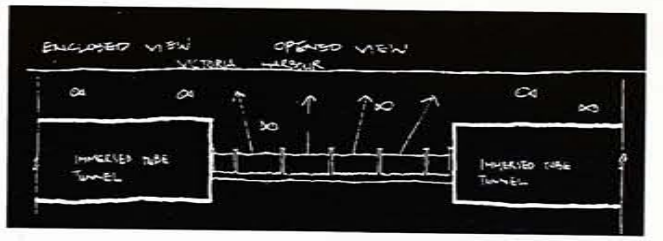


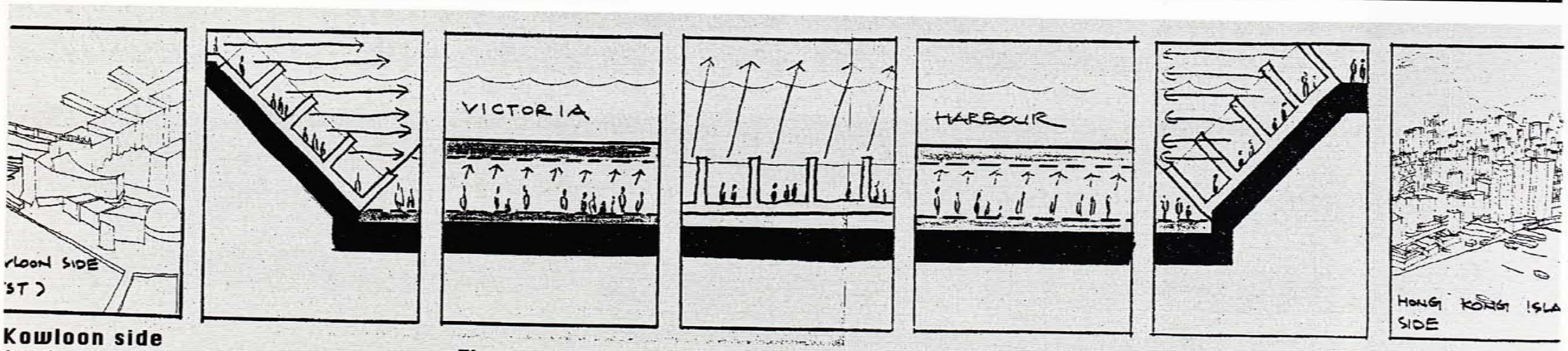
China Bank

Central Plaza

6.1.2 View in/out

The proposed tunnel can be divided into 3 pieces and form a A-B-A pattern. The first and the last section will be focused on tunnel inside with diferent activities happen. The middle part will be more open to underwater and have a long distance view out. As a result, a change on spacial feeling will be achieved by the view in and view out design.





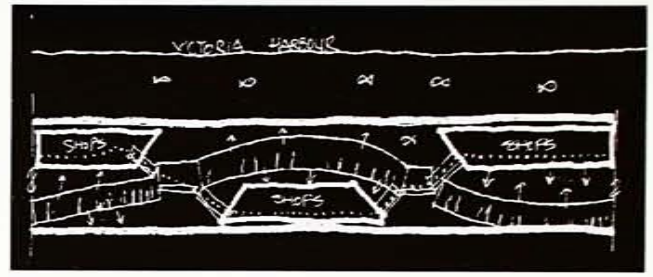
Kowloon side (TST)

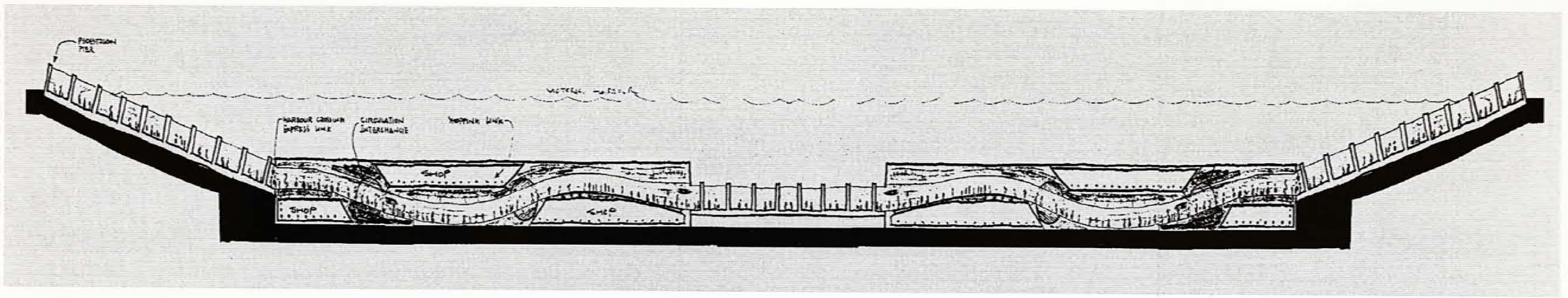
The proposed underwater pedestrian harbour crossing

HK Island (Central Basin)

6.1.3 Up and down zoning

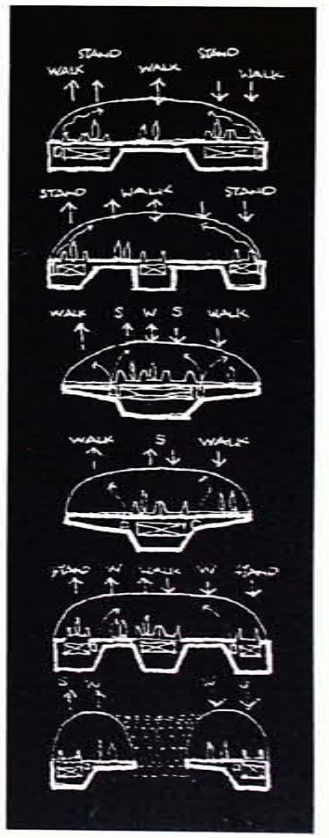
As the proposed tunnel is located in underwater, the dynamic feeling of underwater environment can be simulated as a design feature of the interior layout of the tunnel. Unlike a typical horizontal onward/forward and left/right above ground feeling, underwater give a strong unstable up and down feeling which is without snese of direction. In the proposed tunnel, by separating the public circulation network and other functional space in a up and down and curve pattern, the sense of underwater up and down dynamic feeling can be reinforced.

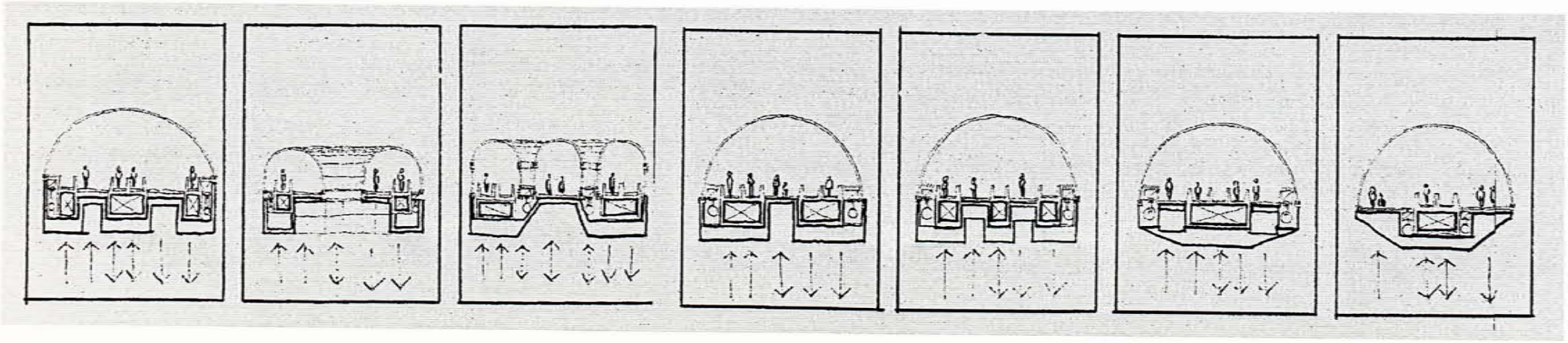




6.1.4 Pedestrian walkway & travelator

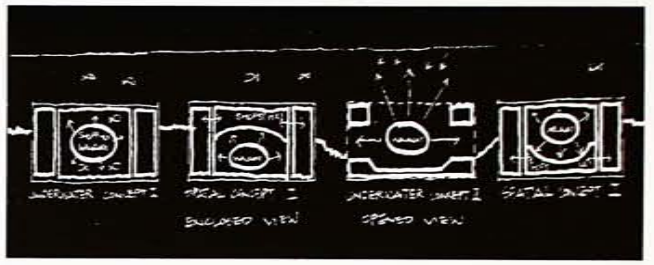
The pedestrian cross harbour link will be the most important function in the proposed tunnel. This network will form by two key elements: pedestrian walkway and people mover or travelator. People can use the pedestrian walkway cross the harbour together with enjoying the activities held along the walkway or just use the travelator as a expressway for harbour crossing. Interchange space between the walkway and travelator will be located at certain points inside the tunnel and people can change the mode of different systems.

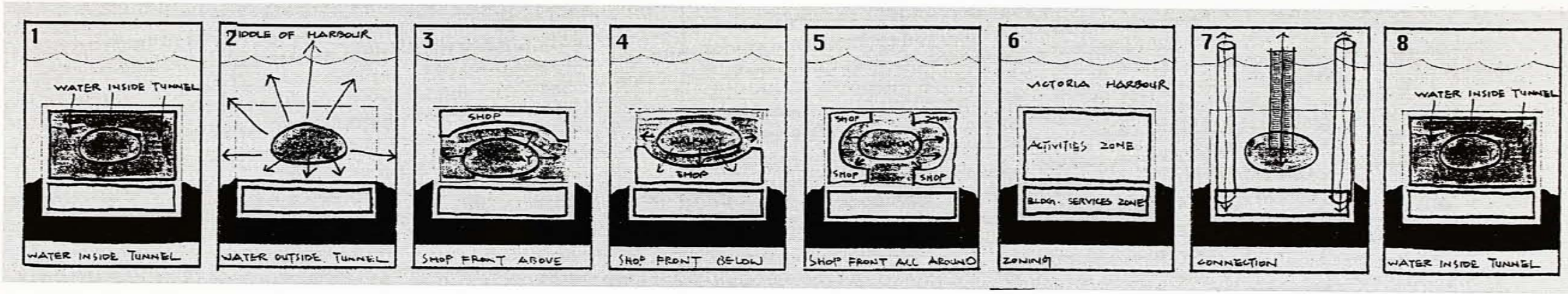




6.1.5 Change of spacial feeling

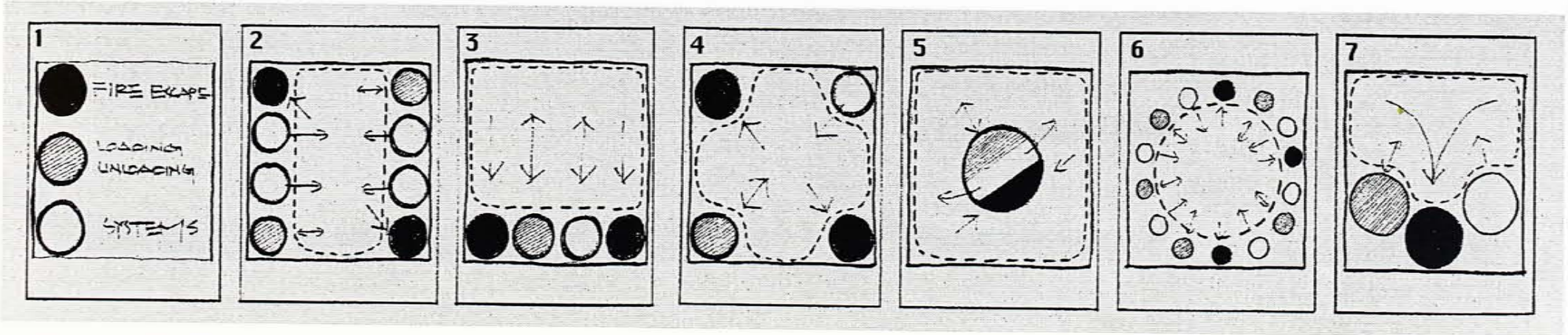
1. Water inside the tunnel and create the aquarium next to the circulation path.
2. The circulation path will direct expose to underwater in a total transparence form.
3. Shops and shop front locate above the circulation path.
4. Shops and shop front locate below the circulation path.
5. Shops and shop front locate all around the circulation path.
6. Services zone locates at the bottom of the tunnel; activities zone above it.
7. Both activities and services zone connect to above ground at the two ends of tunnel.
8. The first and the last part can be in the same treatment so as to echo to each other.

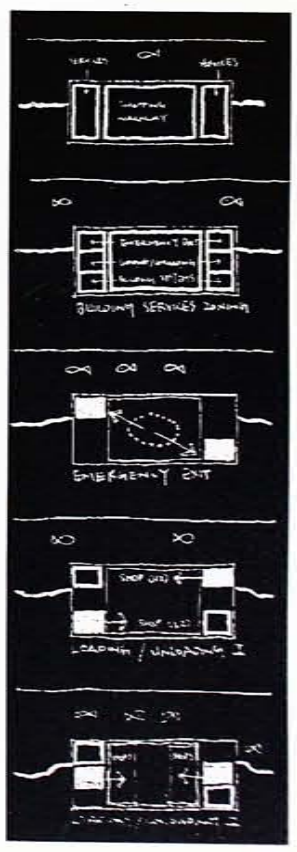




6.1.6 Types of zoning

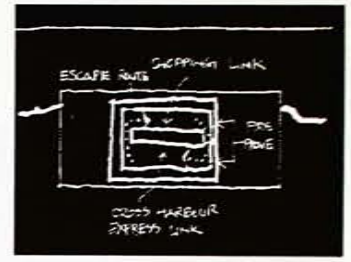
1. Fire excapes, loading/unloading and building systems are major elements of services zone.
2. Service zones are located at two sides of the tunnel. Middle is activities zone and can be extent in up and down pattern.
3. Service zones are located at the bottom of the tunnel. Activities zone above it and can extent to other three directions.
4. Service zones are located at the four corners of the tunnel.
5. Service zones are centralized in the central part of the tunnel.
6. Service zones are break down and surround the activities zone.
7. Service zones are located at bottom part of the tunnel and form a triangular pattern.

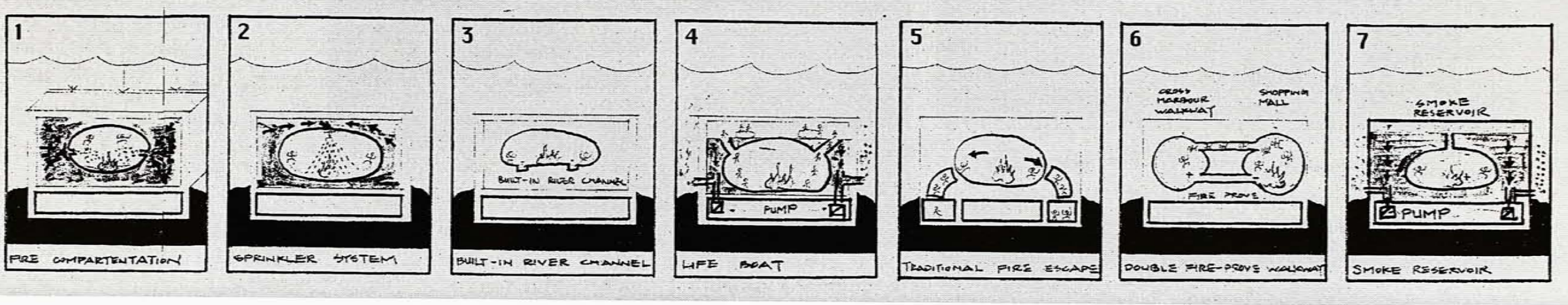




6.1.7 Concepts on fire services

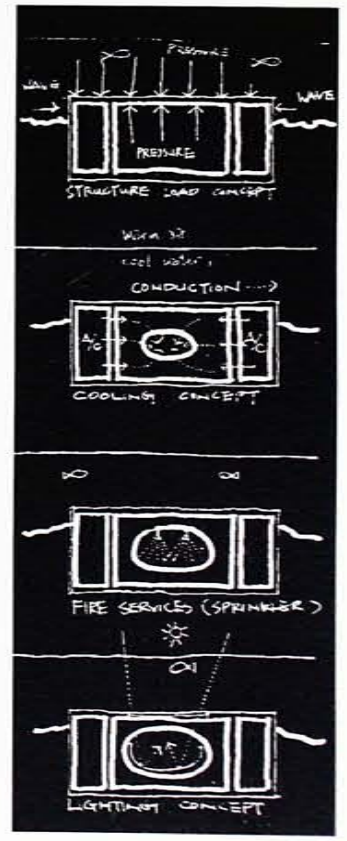
1. The tunnel is divided to several sections and served for fire compartmentation.
2. Water inside the tunnel can be used by the sprinkler system.
3. The built-in water channel in the circulation path can not only stop the spread of fire but also as a design feature.
4. Lift boat can be used as one of the fire escape means in the water inside the tunnel.
5. Typical fire protected escape routes provide basic means of escape.
6. It is possible to make the circulation path become fire protected.
7. The remaining space of water tank can be served as smoke reservoir.

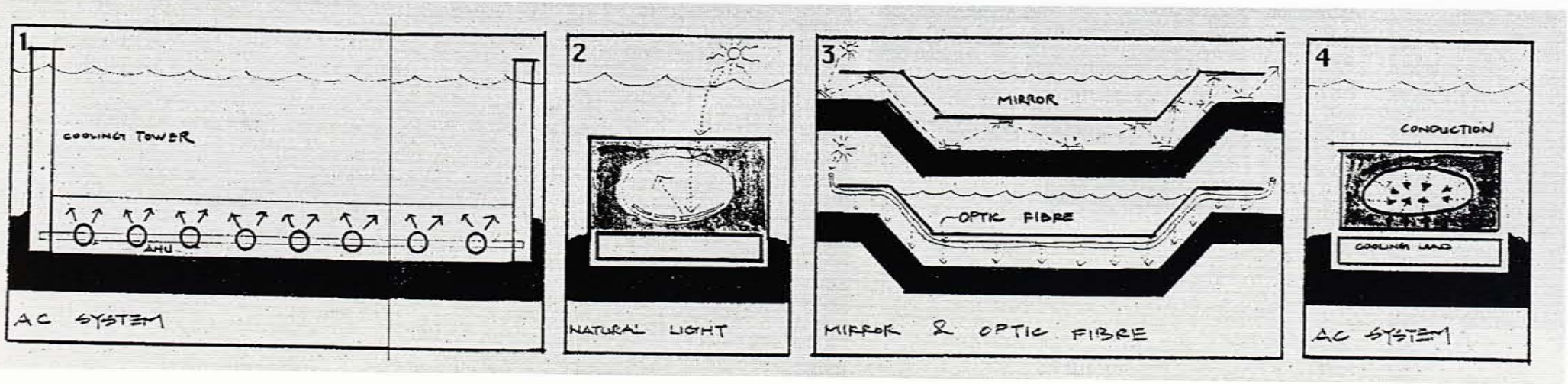




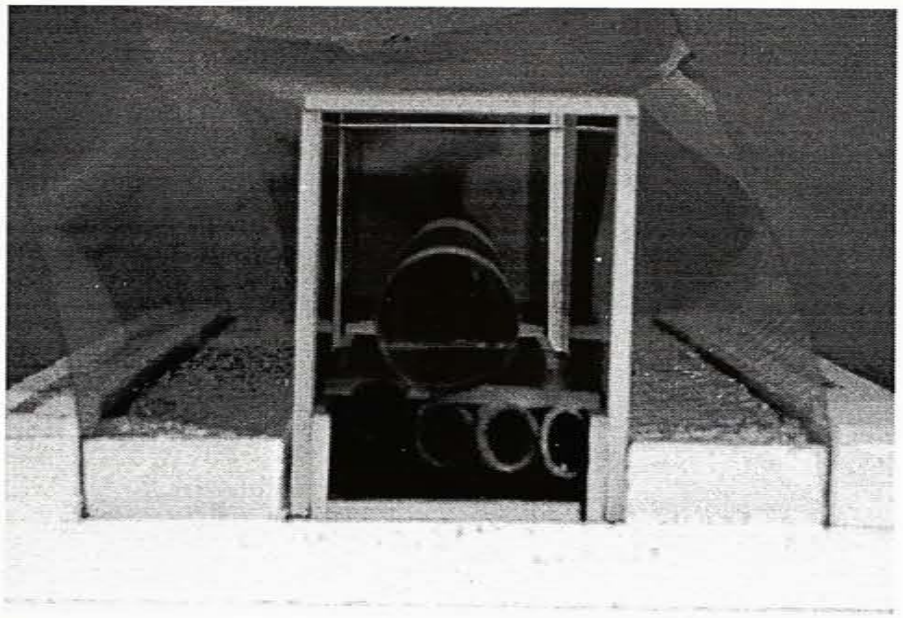
6.1.8 Concepts on other systems

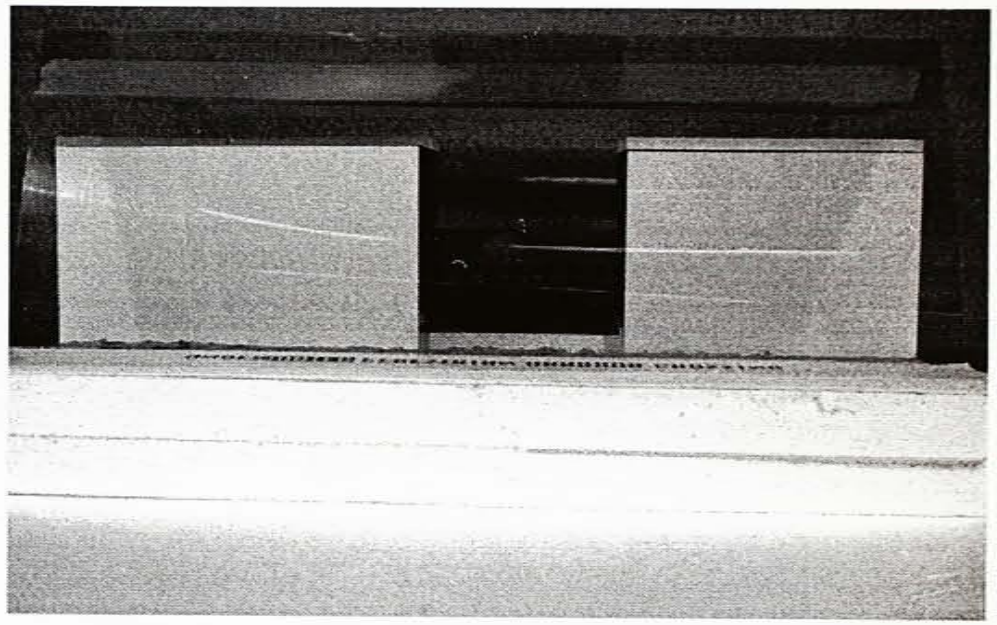
1. A/C cooling plants will be located next to the two entances and major air duct will provide cooling load to individual AHU systems which install in each tunnel section.
2. The glass tunnel will bring daylight into the interior of the tunnel space.
3. By using series of glass mirror or optic fibre can bring daylight into the interior of the tunnel.
4. The cooling can be transferred in the form of conduction through the water to the circulation path.

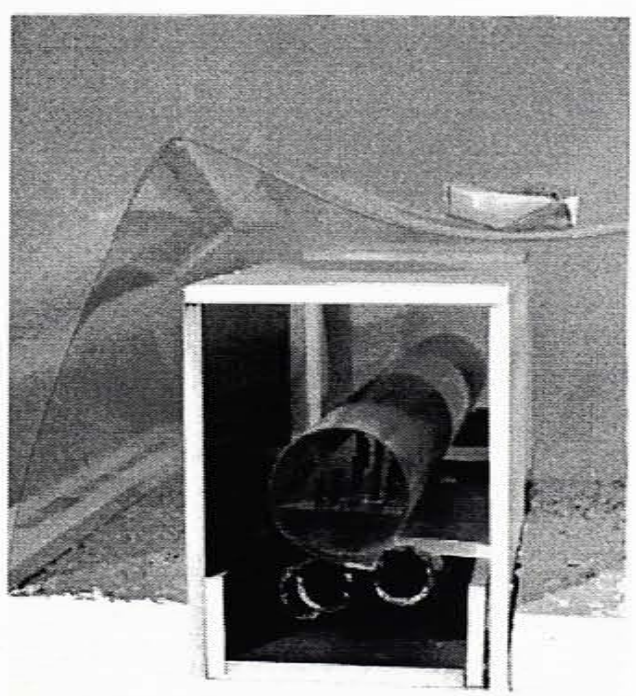


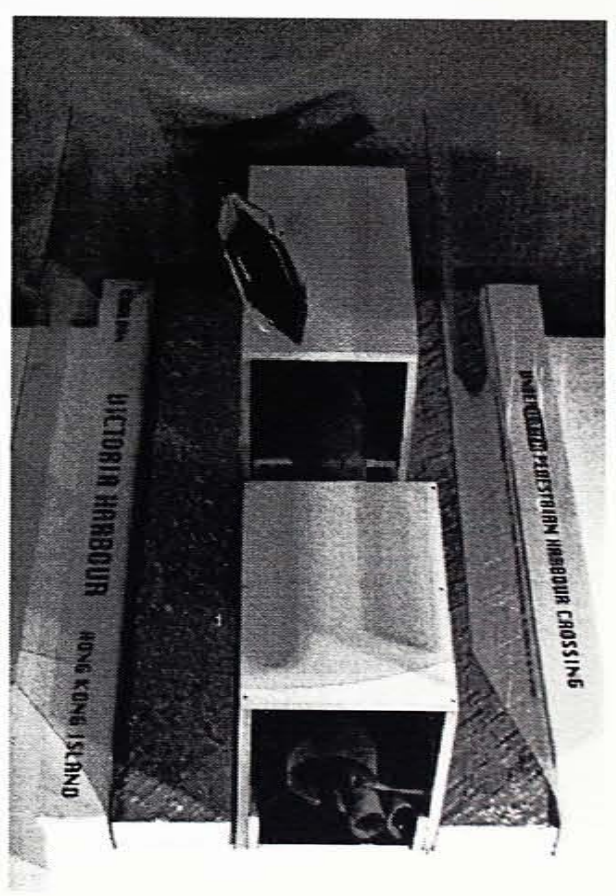


6.1.9 Conceptual model



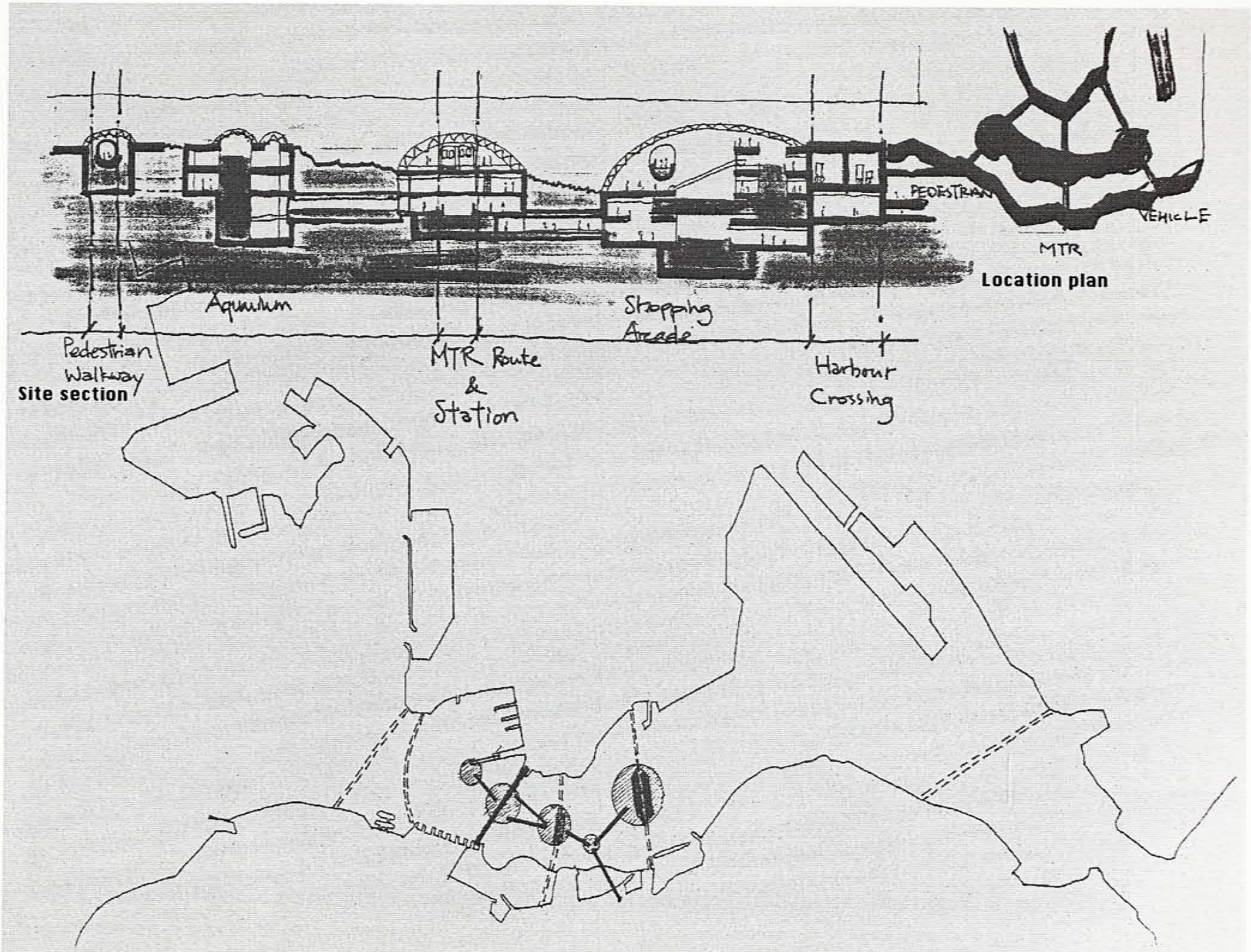






6.2 MASTER LAYOUT PLAN DEVELOPMENT

6.2.1 Option 1

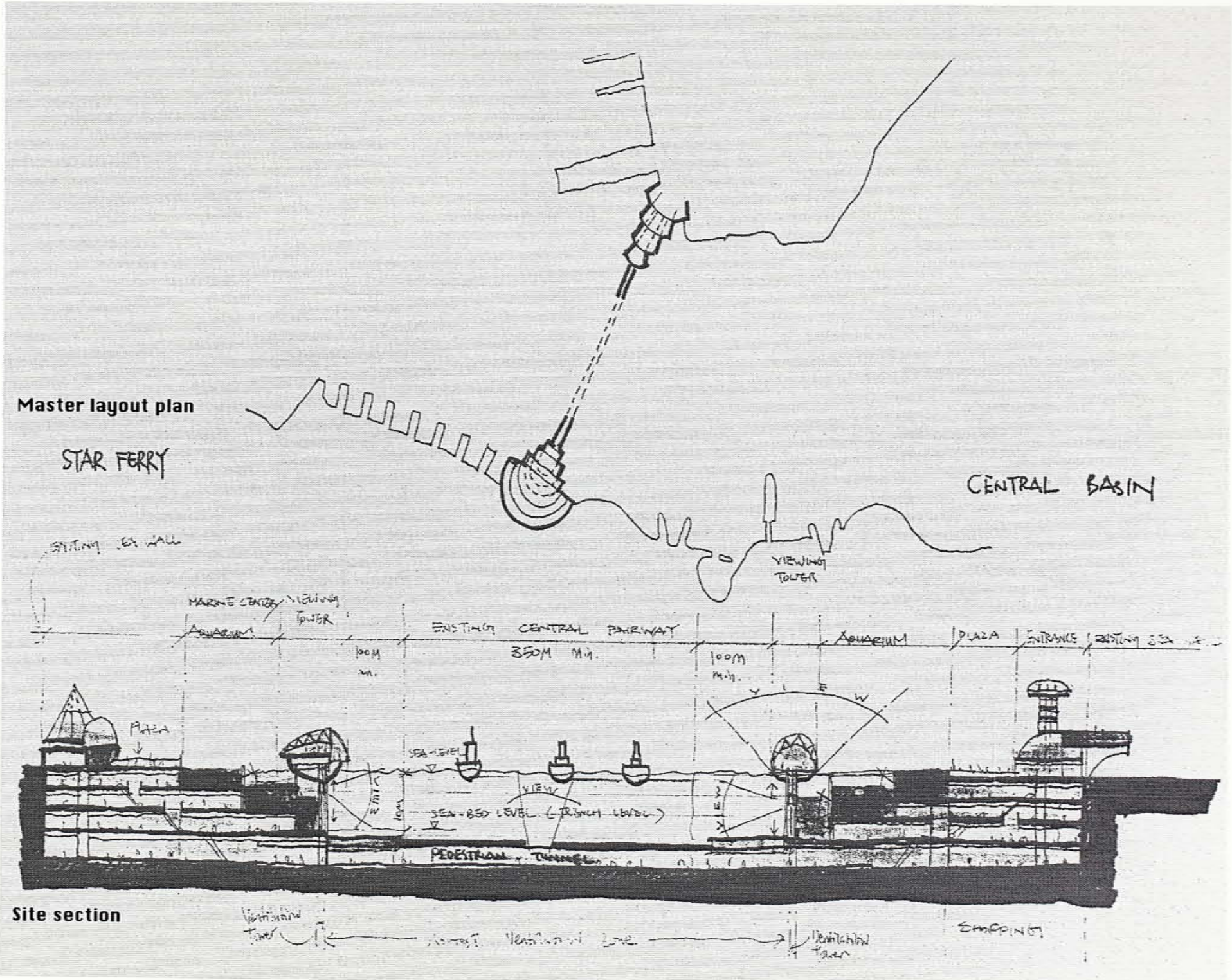


Site section

Location plan

Master layout plan

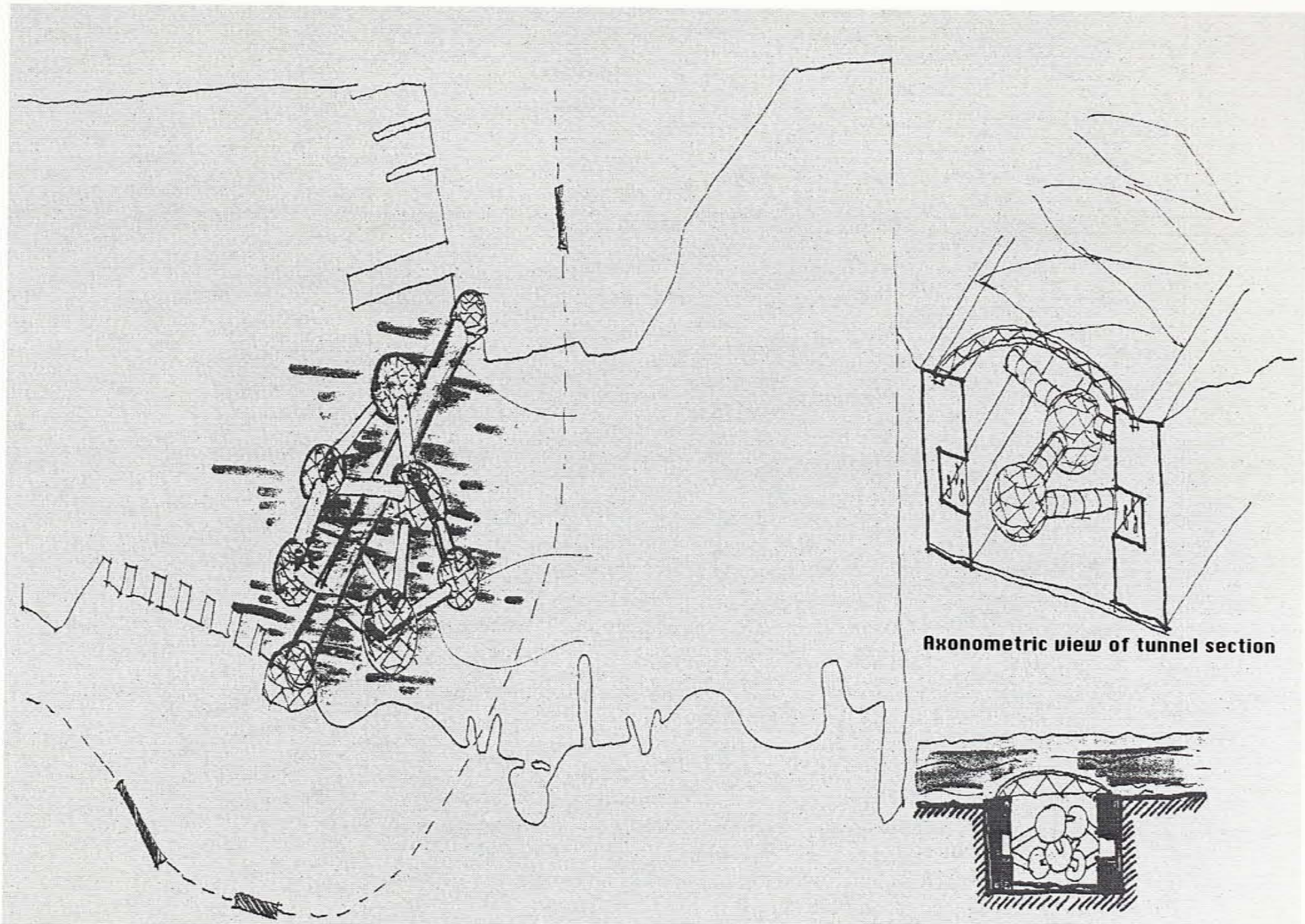
6.2.2 Option 2



Master layout plan

Site section

6.2.3 Option 3



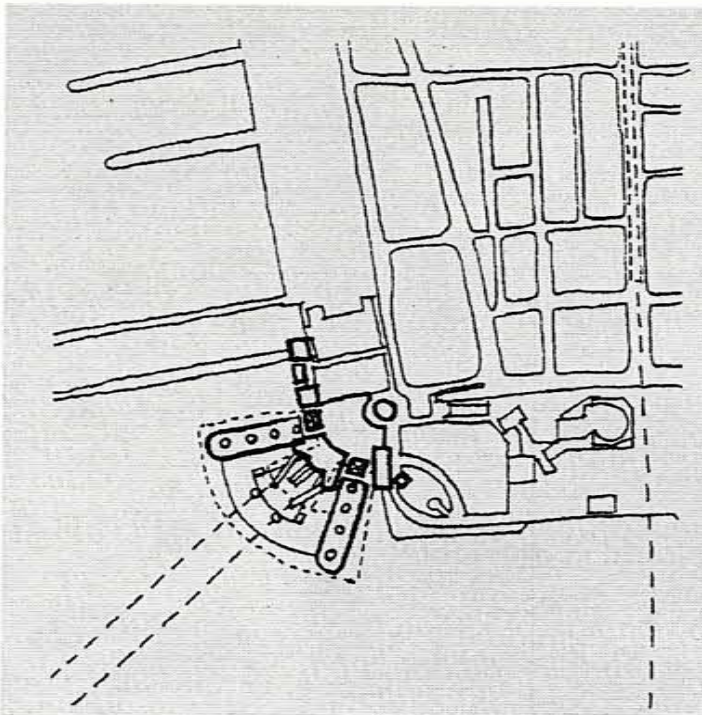
Master layout plan

Axonometric view of tunnel section

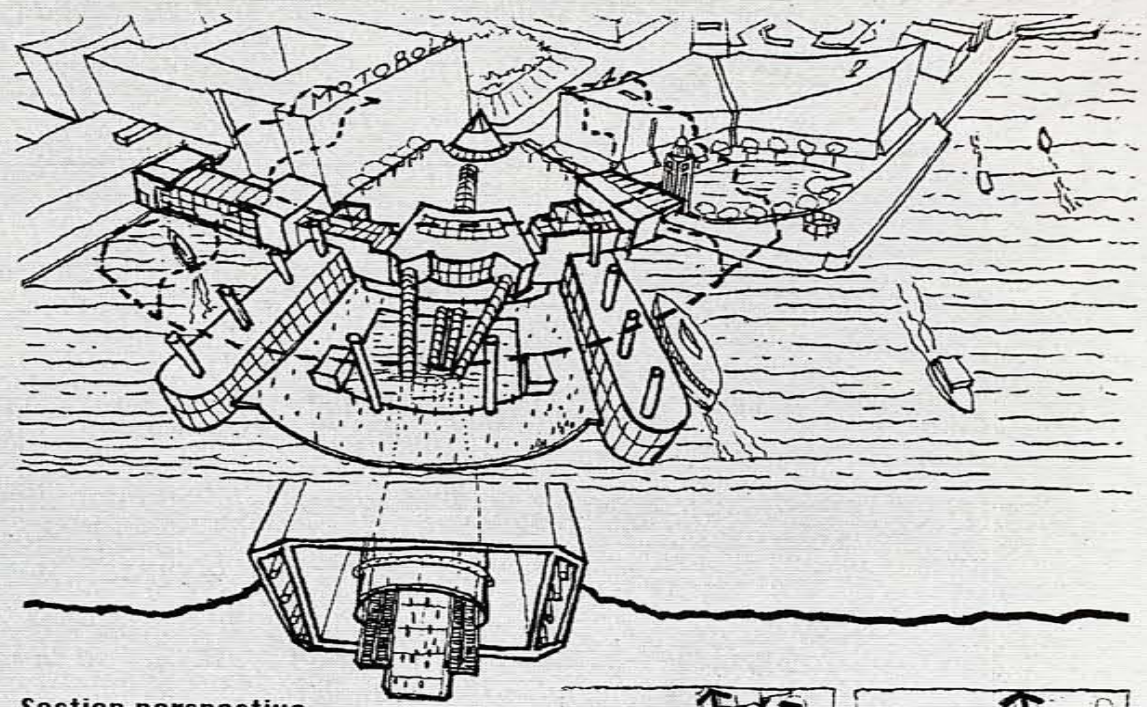
Typical section

6.3 SCHEMATIC DESIGN

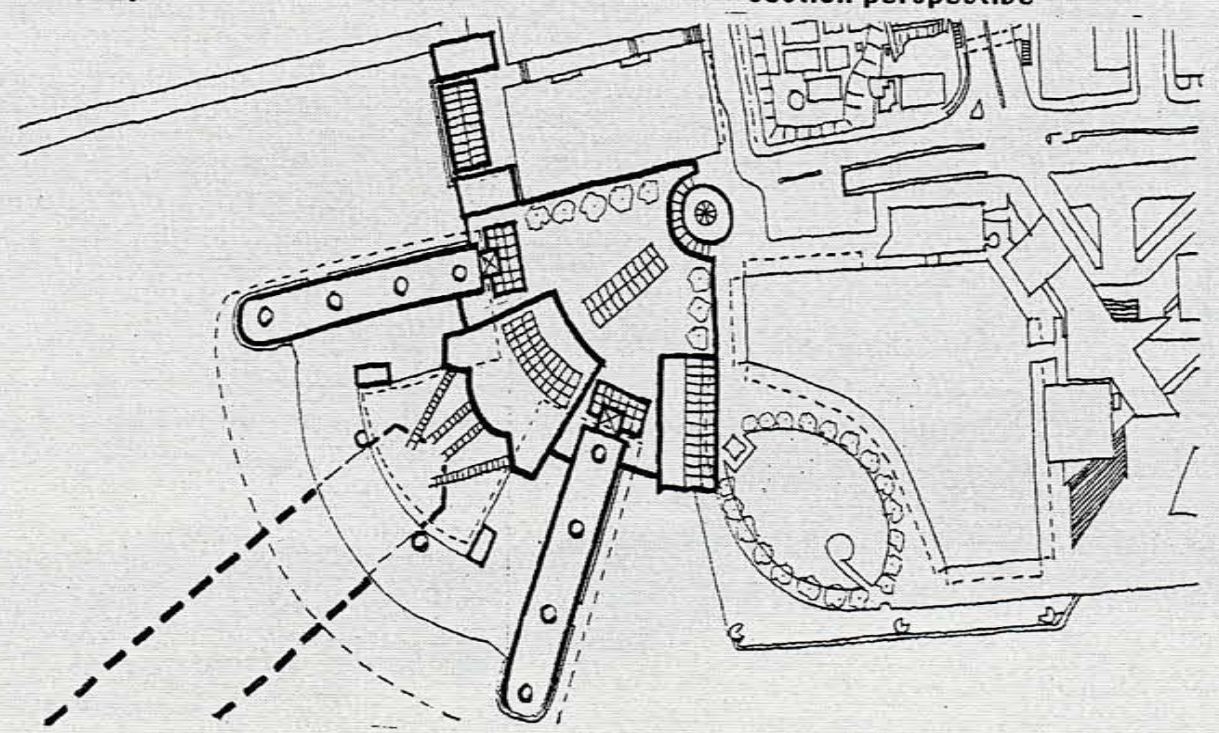
6.3.1 Star Ferry Pier (TST) Master Layout



Location plan



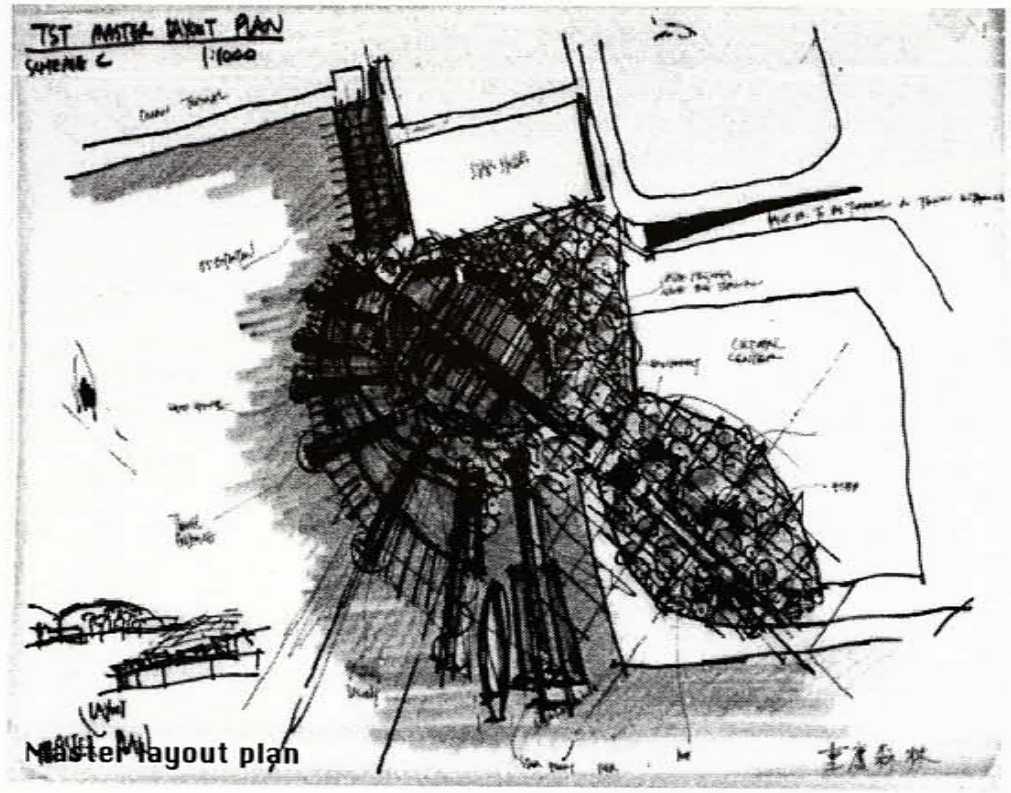
Section perspective



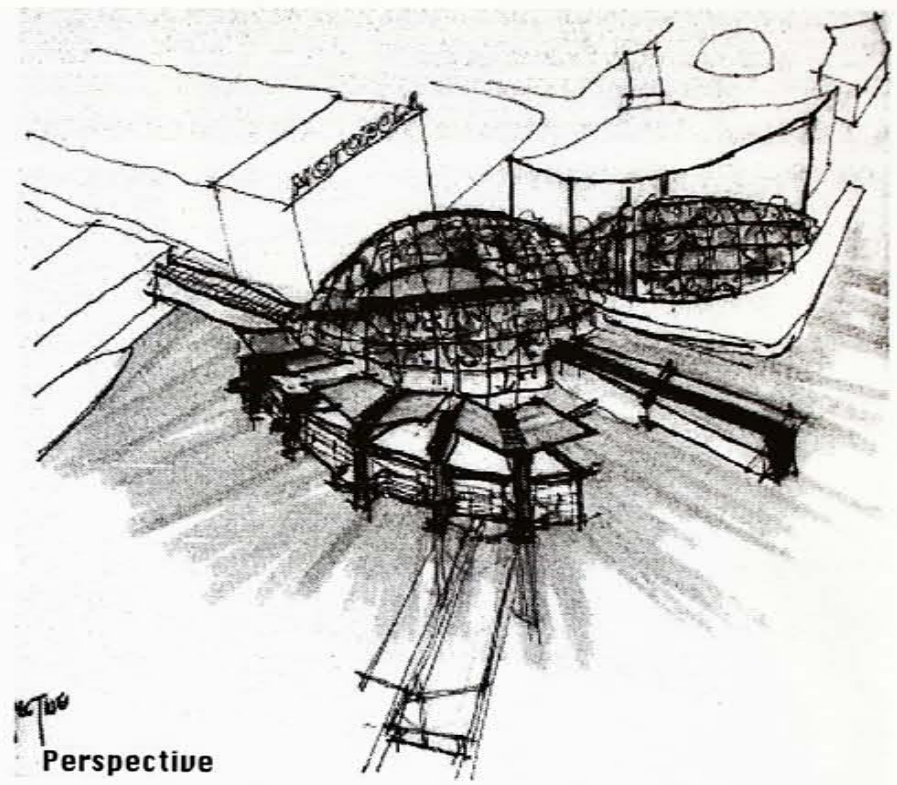
Master layout plan

Option 1

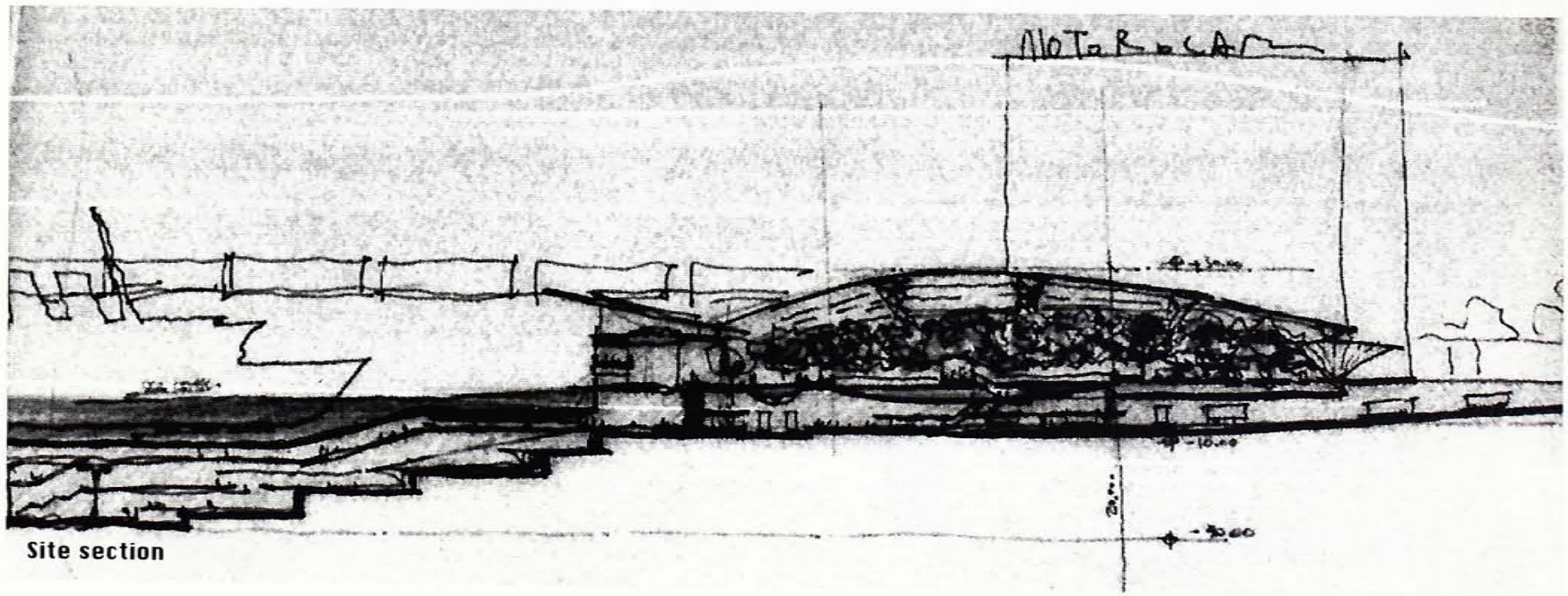
Conception diagrams



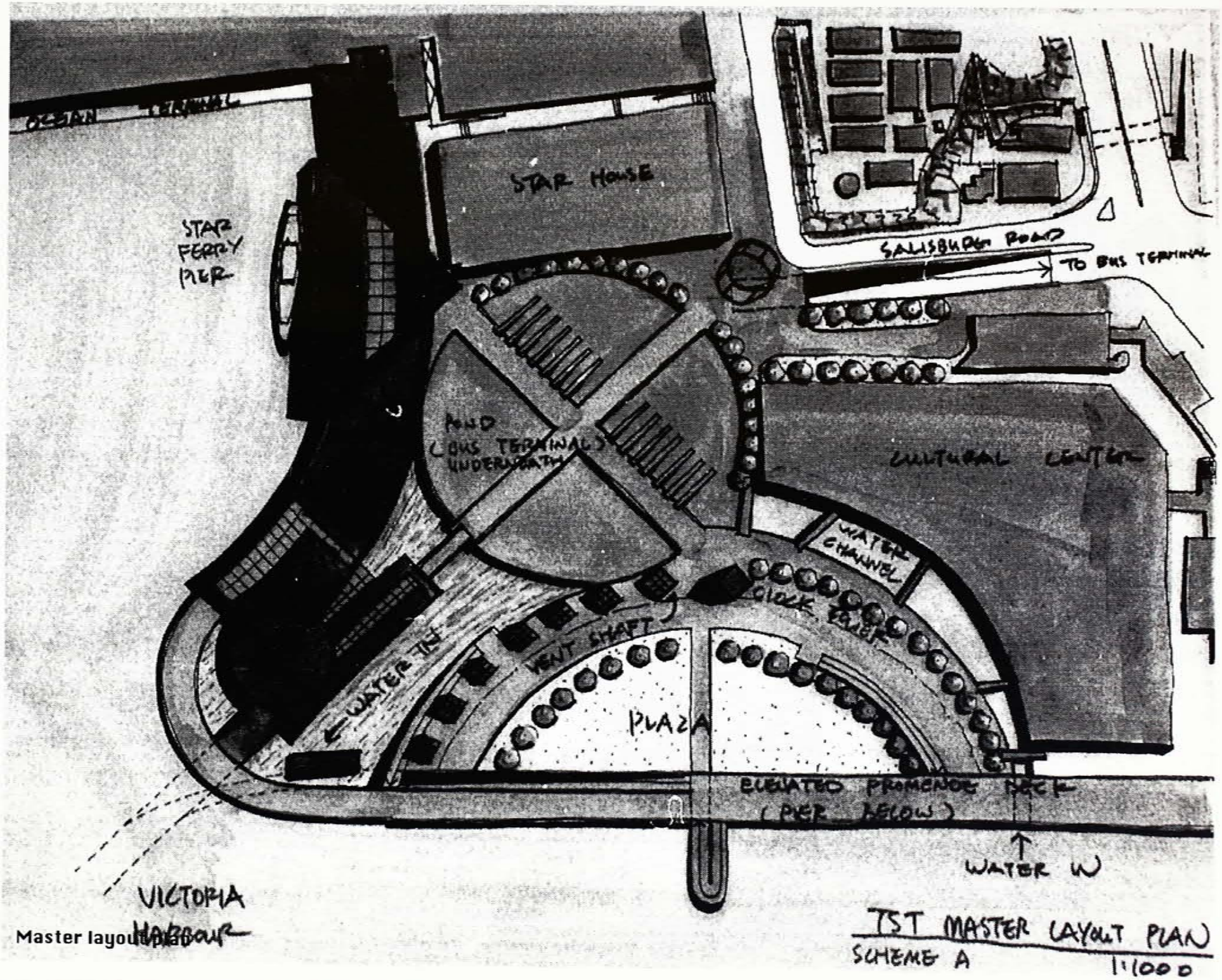
Master layout plan



Perspective

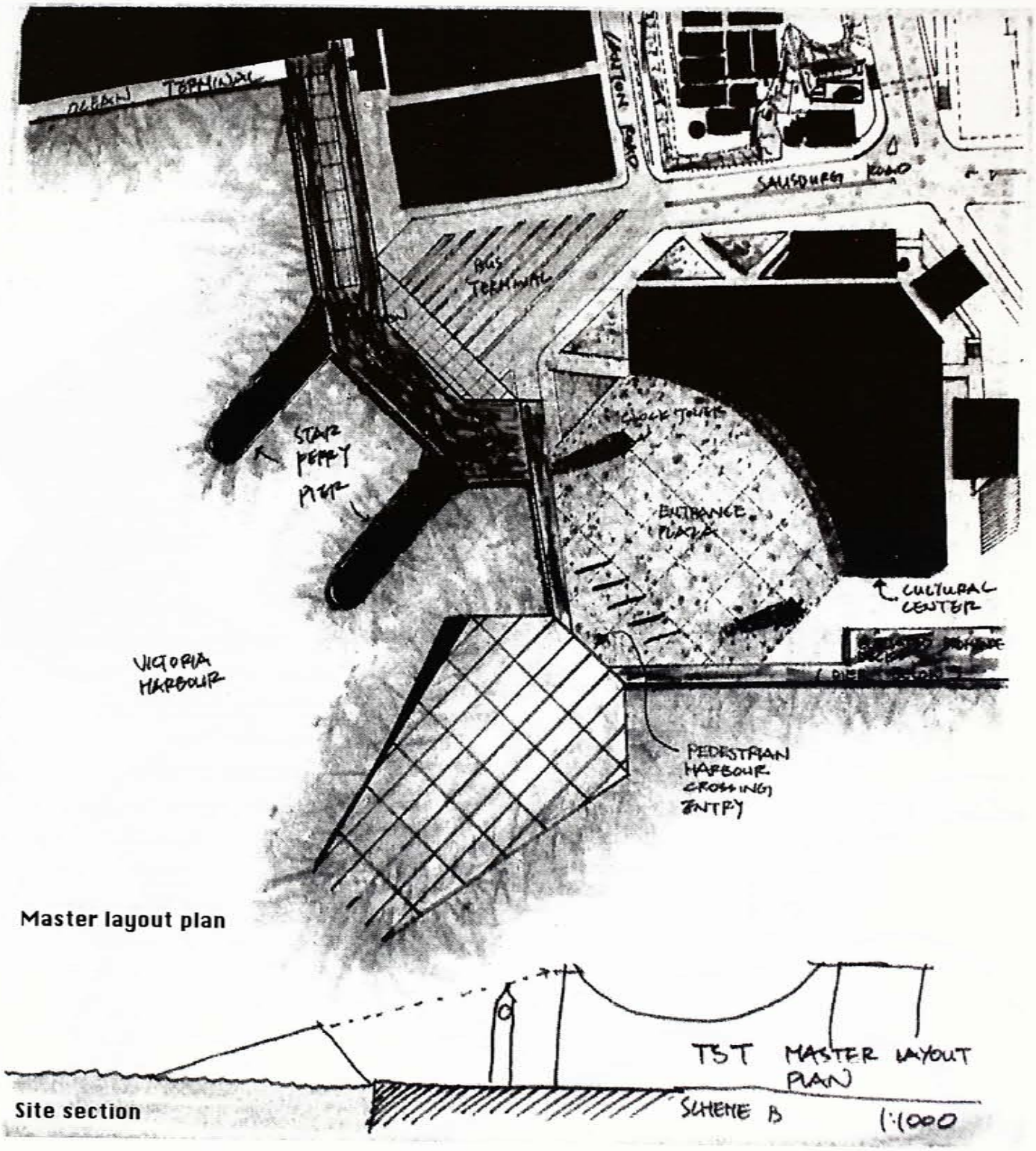


Option 2 Site section



Option 3

Master layout plan



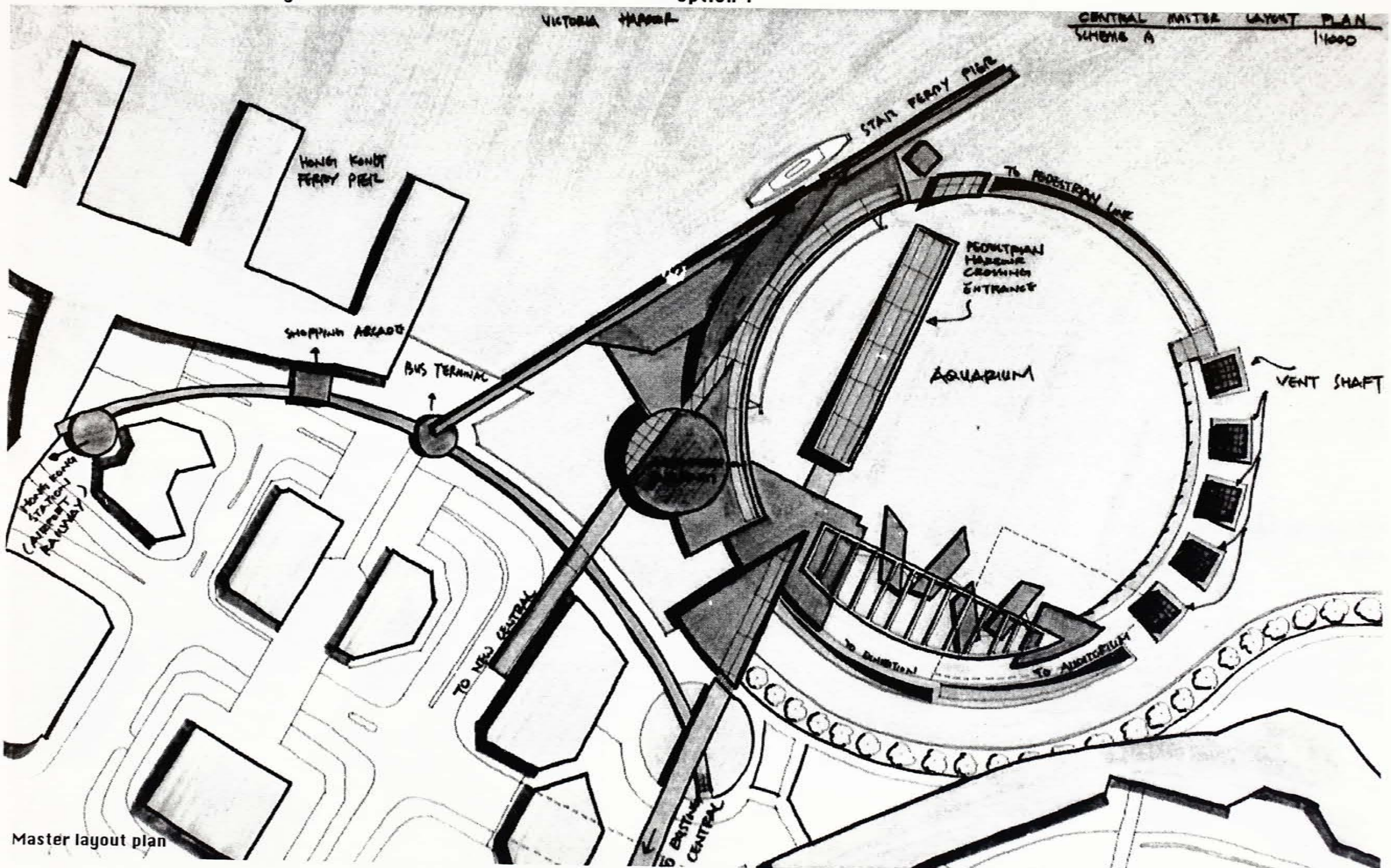
Master layout plan

Site section

Option 4

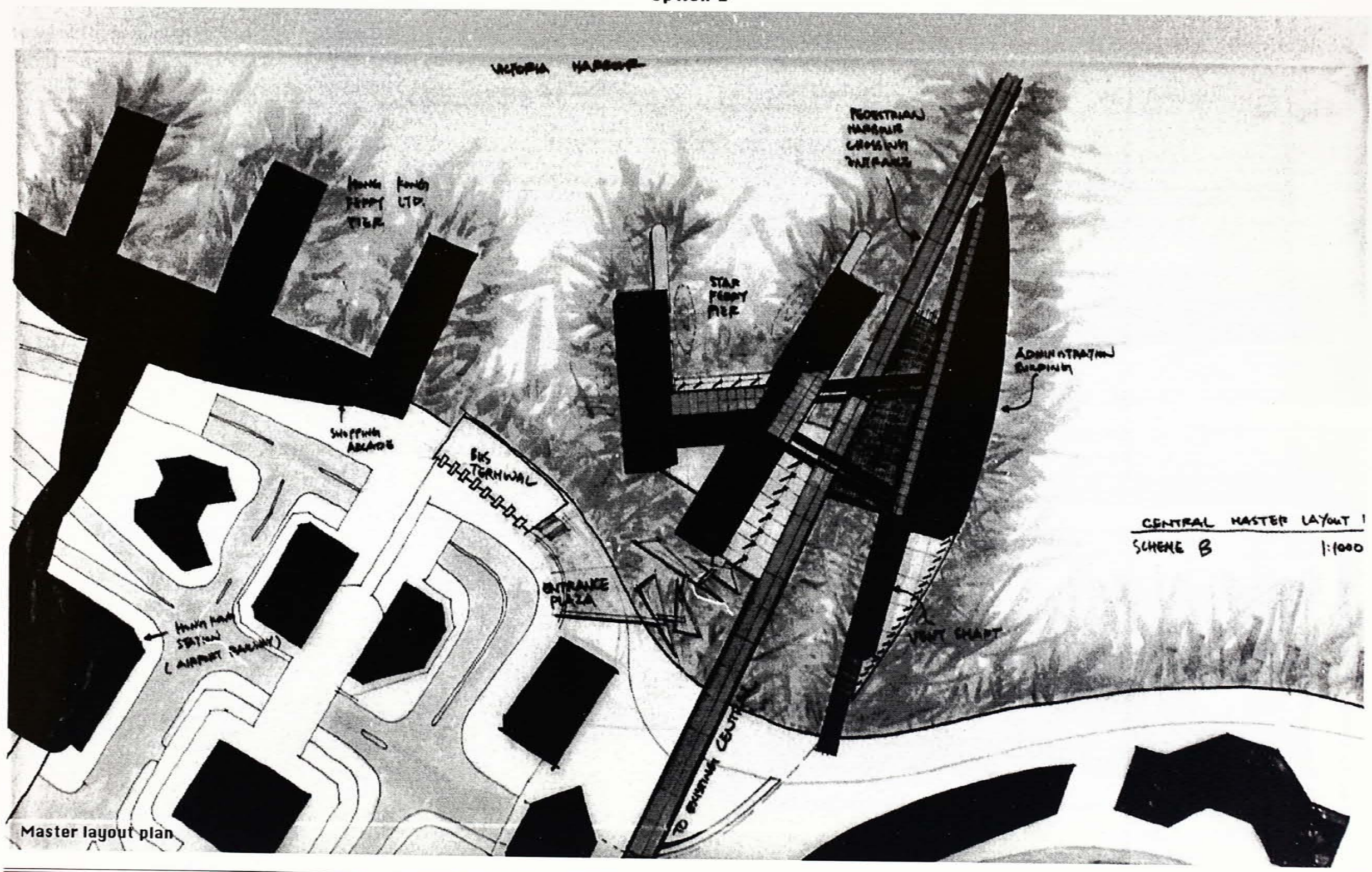
6.3.2 Central Basin master layout

Option 1



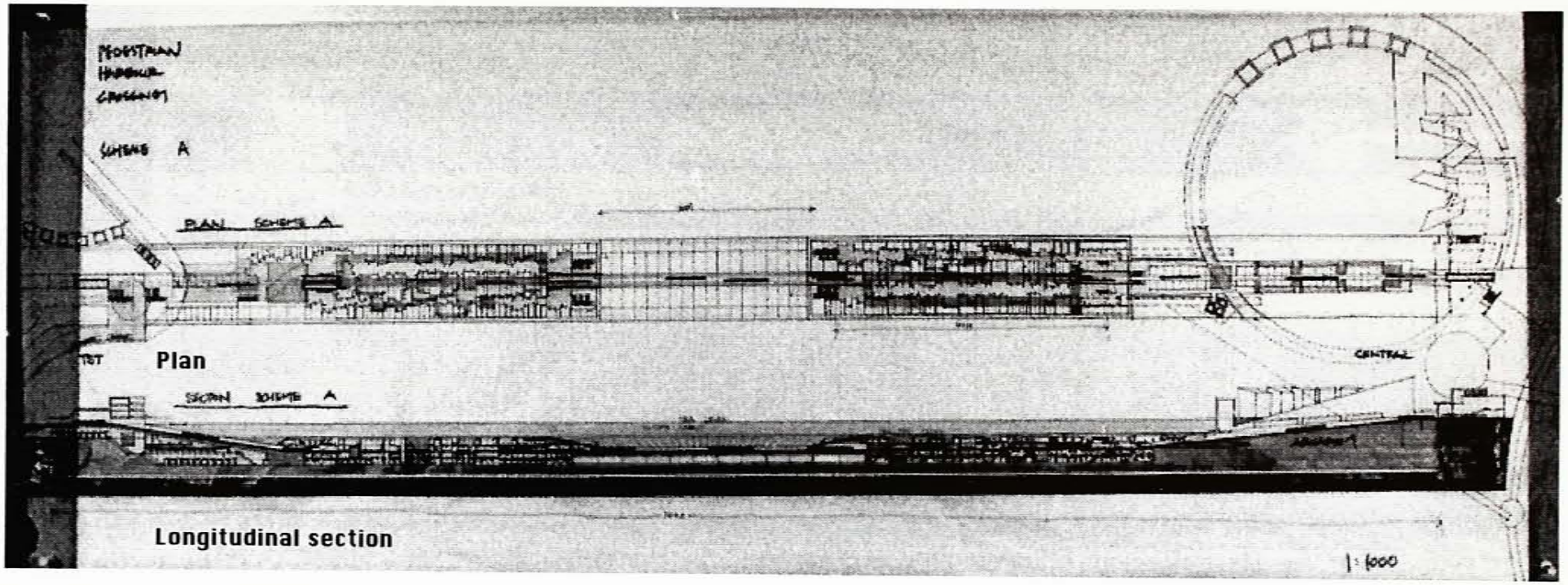
Master layout plan

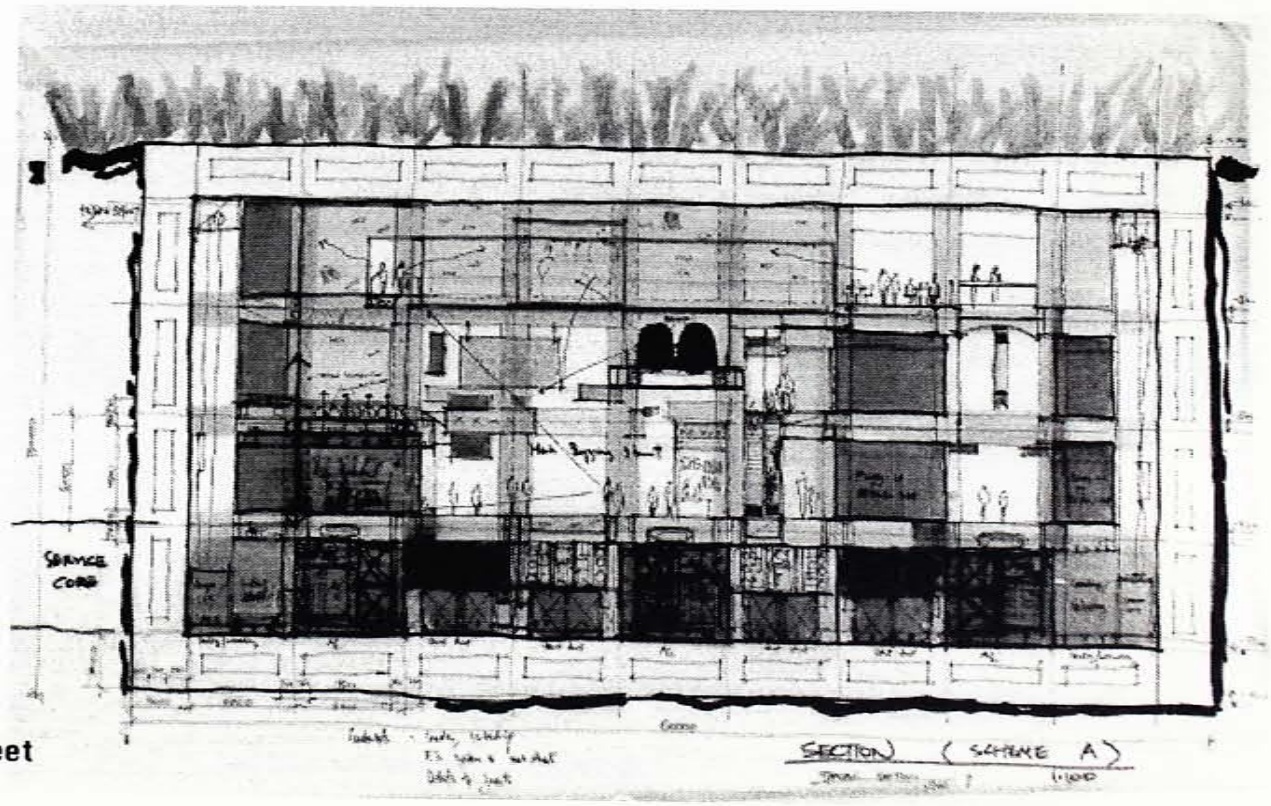
Option 2



Master layout plan

6.3.3 Pedestrian tunnel schematic design

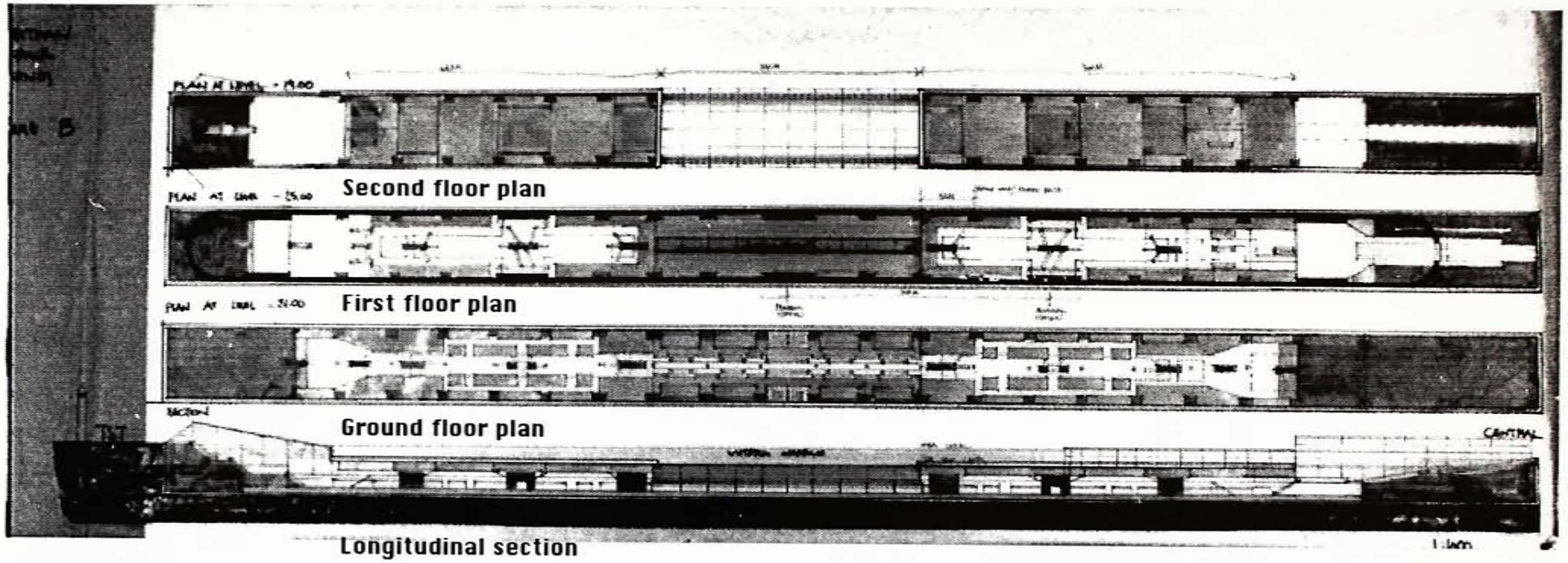


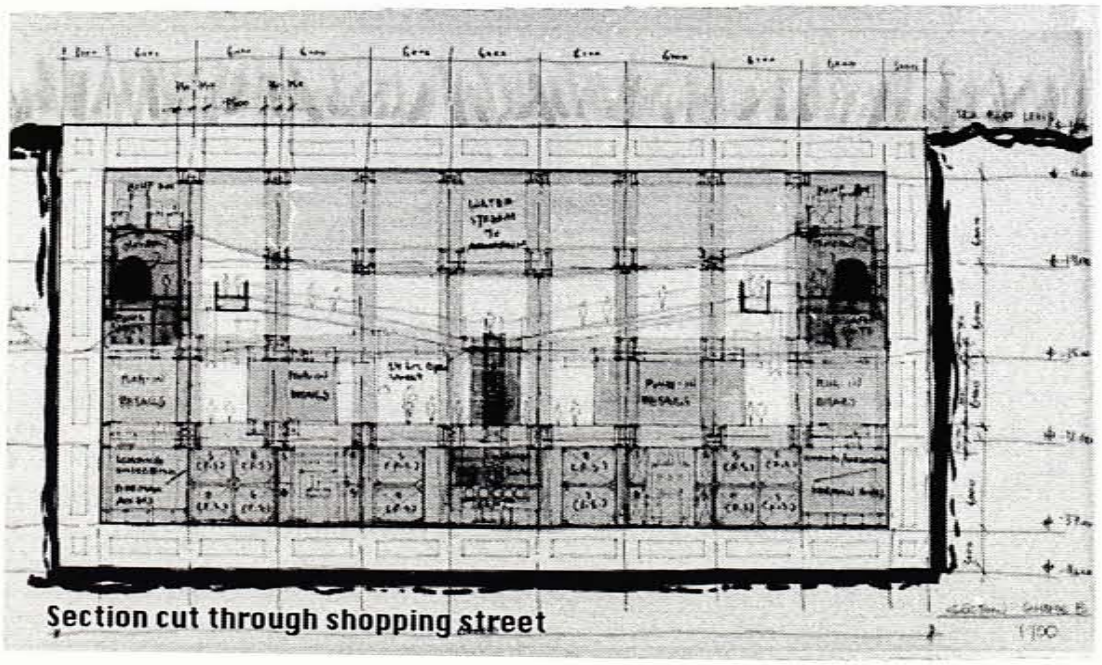


Option 1 (design with TST option 3 & Central Basin option 1)

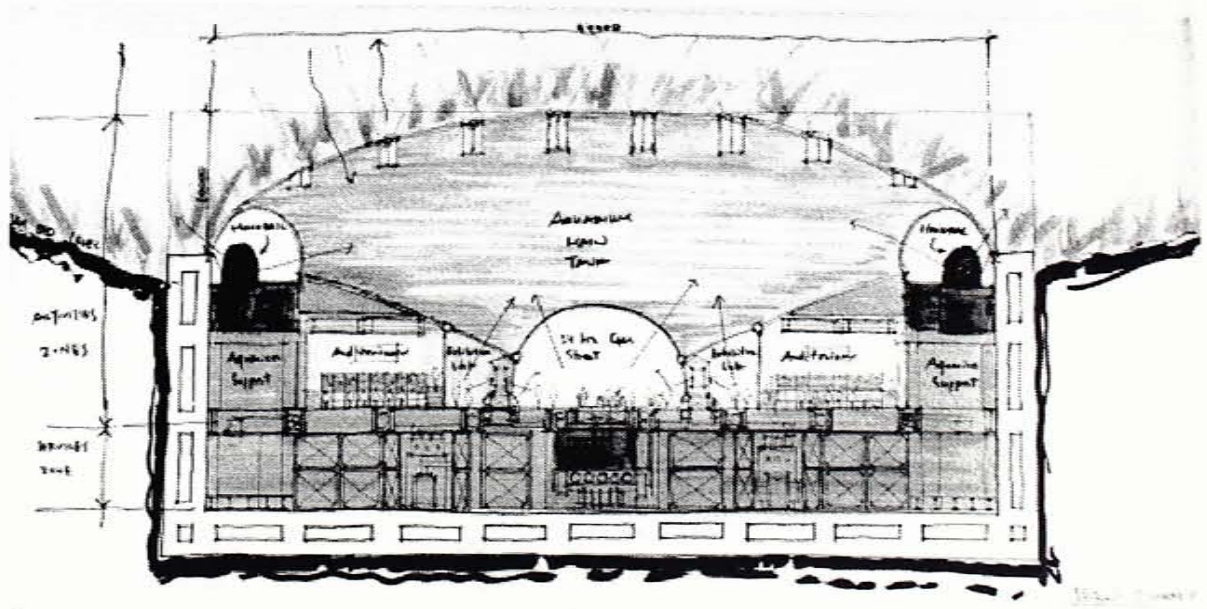
Section cut through shopping street

Option 2 (design with TST option 4 & Central Basin option 2)



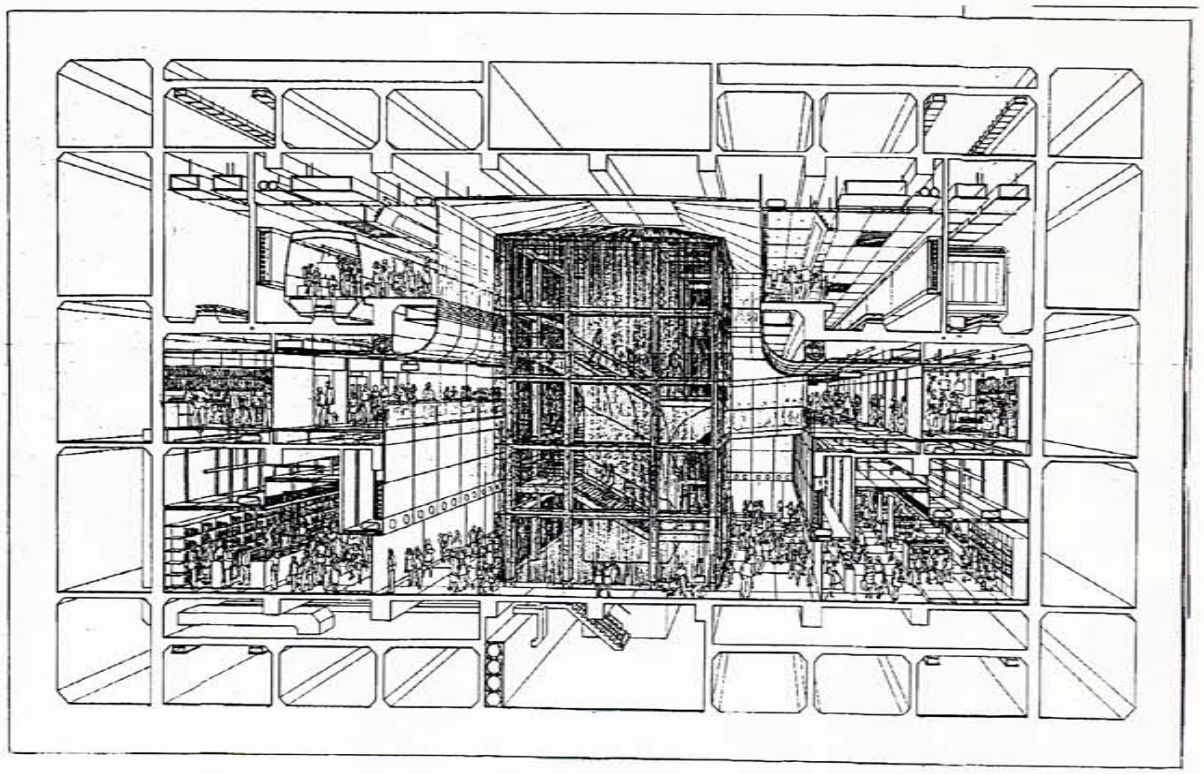


Section cut through shopping street

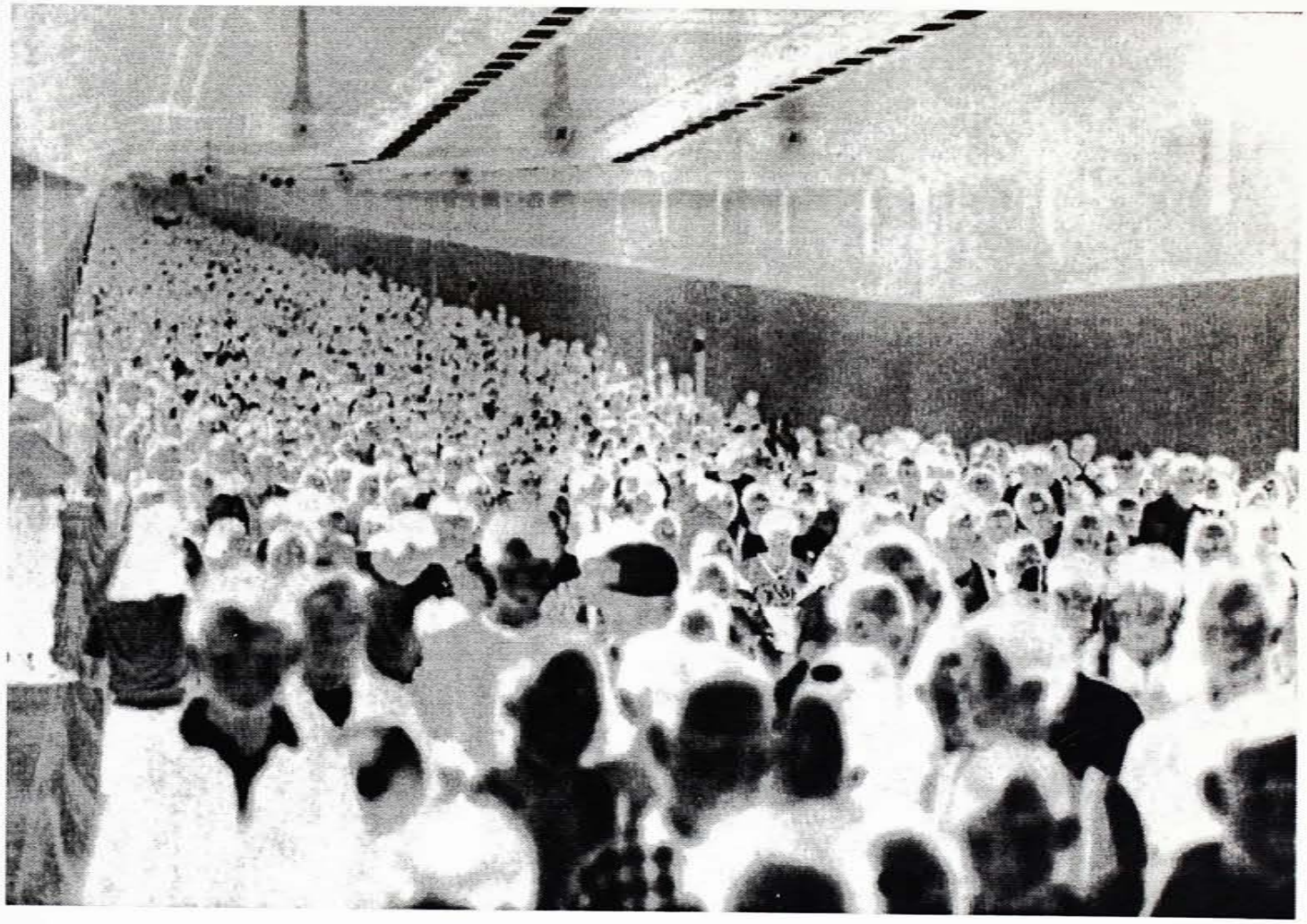


Section cut through aquarium

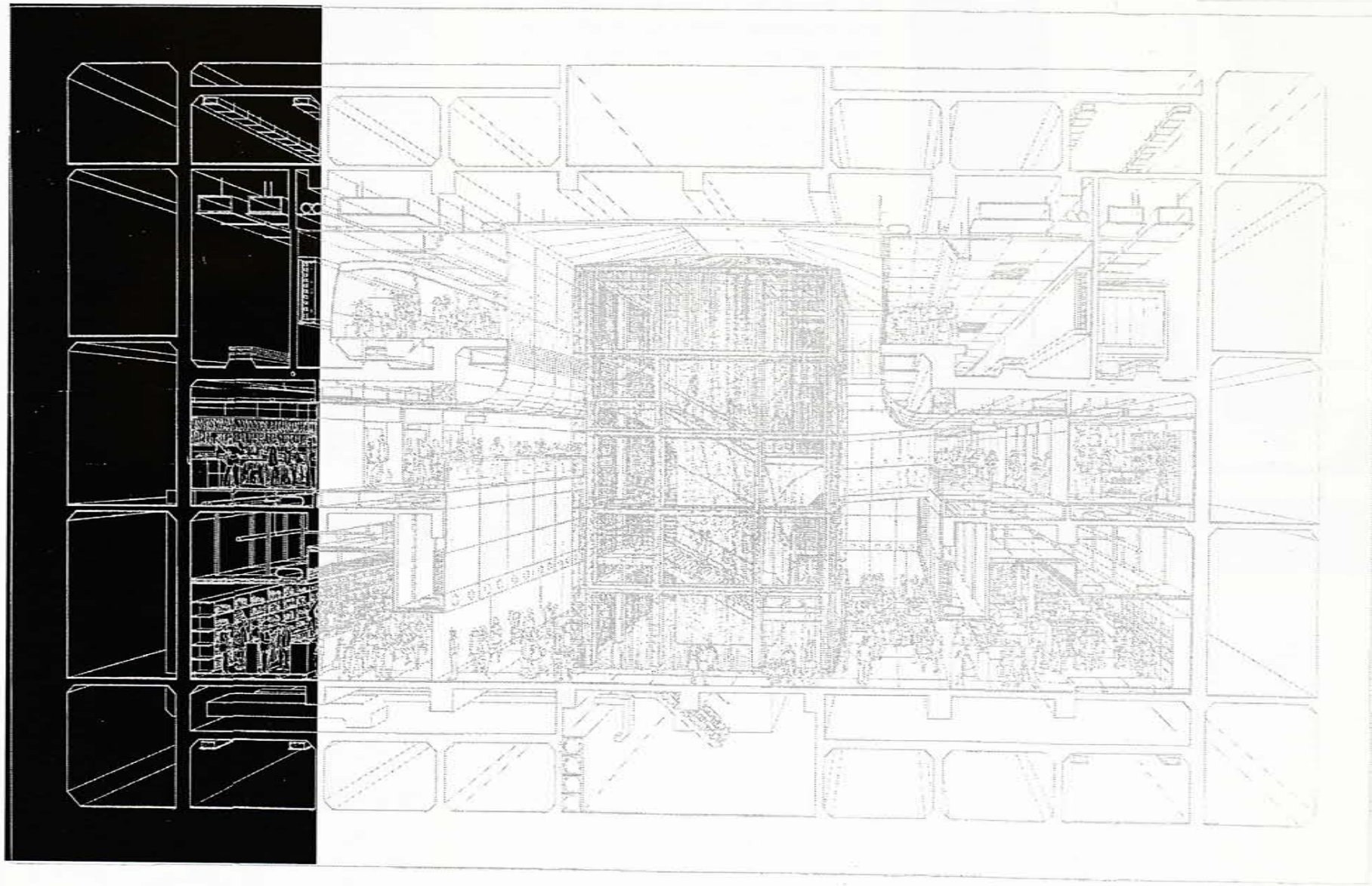
CHAPTER 7 FINAL DESIGN



You can walk on dry ground in the middle of the harbour.



7.1 PRE-CONCEPT

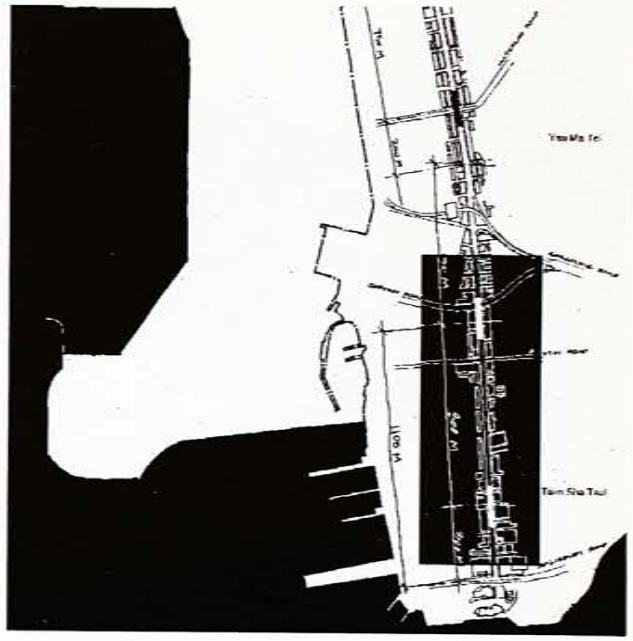


7.11 DEVELOPMENT POTENTIAL OF CROSS HARBOUR TRAFFIC

Along the two waterfronts of the Victoria Harbour are the most busy commercial and cultural areas in Hong Kong, it will has high commercial value if a new 'development' can be taken place so as to connect the two waterfronts. This 'development' can physically create another network for people across the harbour and will have very high commercial value, especially retails trade due to the high pedestrian flow everyday.

7.12 DISTANCE COMPARISON

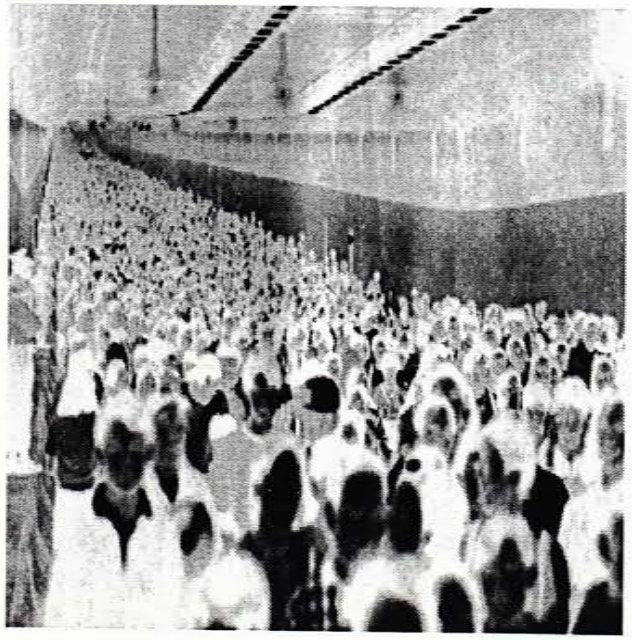
The shortest distance between the Victoria Harbour after complete the land reclamation project is no more than 1,000m, which is equal to part of Nathan Road from Tsim Sha Tsui to Jordon. People will need about 16 minutes to walk through this distance (1m per second).



7.13 PEOPLE WALK ACROSS THE HARBOUR

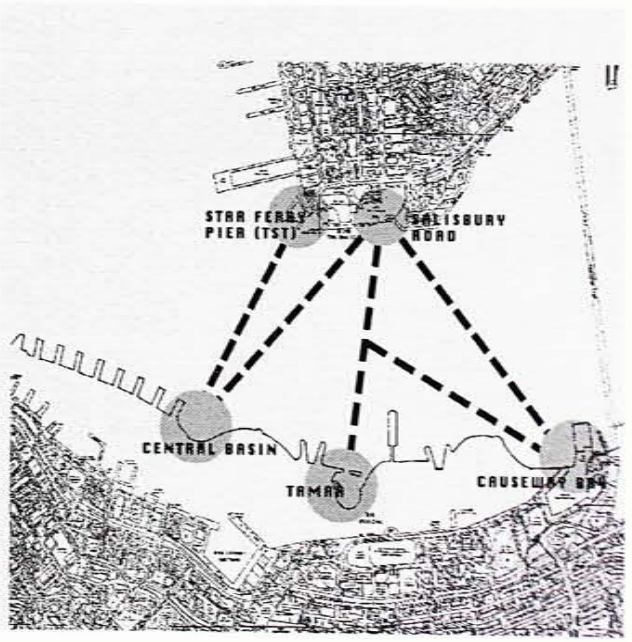
The underlining concept is to build a pedestrian harbour crossing tunnel to connect the most busy district along the waterfront, that is Tsim Sha Tsui in Kowloon side and the northern side of Hong Kong Island (both Central, Admiralty, Wan Chai & Causeway Bay have potential to become the tunnel entrance in HK Island).

The objective of the tunnel is to connect the CBD areas of Kowloon side and Hong Kong Island side physically in order to create a high commercial quality development. Besides, the tunnel can provide another linkage for people to cross the harbour.



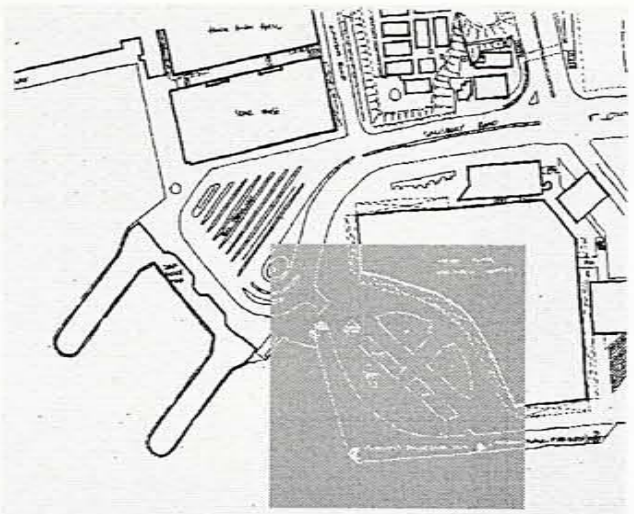
7.14 CHOICES OF TUNNEL ROUTE

Several choices of route of the proposed pedestrian harbour crossing tunnel have a detail study. In Kowloon side, Star Ferry Pier and Salisbury Road are selected. In HK Island side, both Central Basin, Tamar and Causeway Bay are selected as the potential location of the tunnel entrance. Furthermore, an idea of creating a new MTR station in the middle of the harbour with connection to the pedestrian tunnel is one of the interest option in the site selection process.



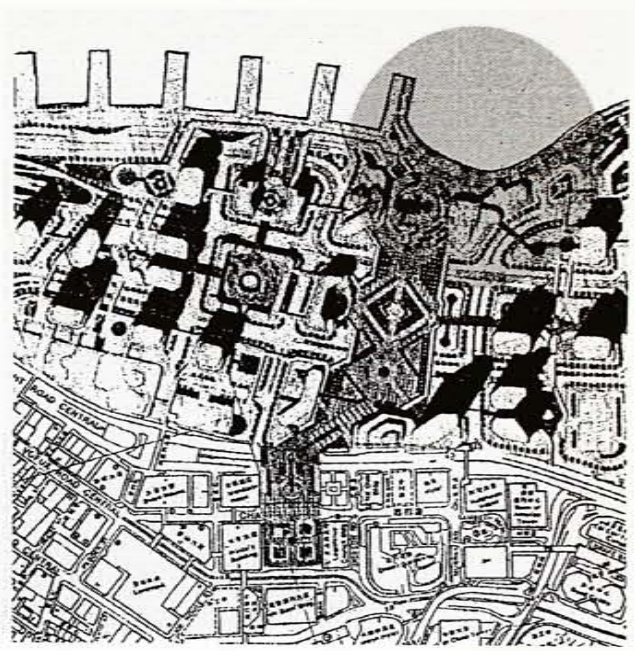
7.15 KOWLOON SIDE ENTRANCE

The final site selection in Kowloon side is the Star Ferry Pier. The site is just next to the Cultural Center and bus terminal. The proposed pedestrian harbour crossing tunnel entrance will locate at the existing open plaza in front of the Cultural Center.



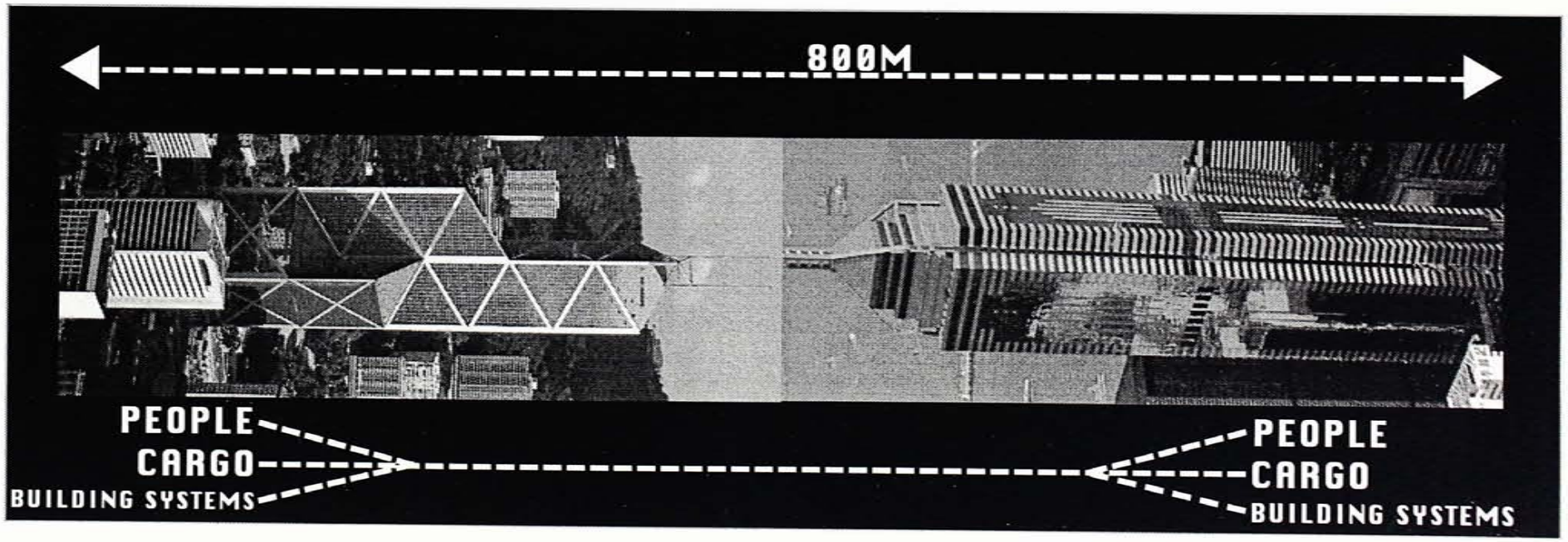
7.16 HONG KONG ISLAND SIDE ENTRANCE

The final site selection in Hong Kong Island side is Central Basin. Central Basin is formed by part of the Central-Wan Chai Reclamation Project. The land reclamation will extent the shore line and create the new commercial district next to the existing CBD. The proposed tunnel entrance will locate at a curve basin shape's shore line and connect to the future elevated landscape garden.

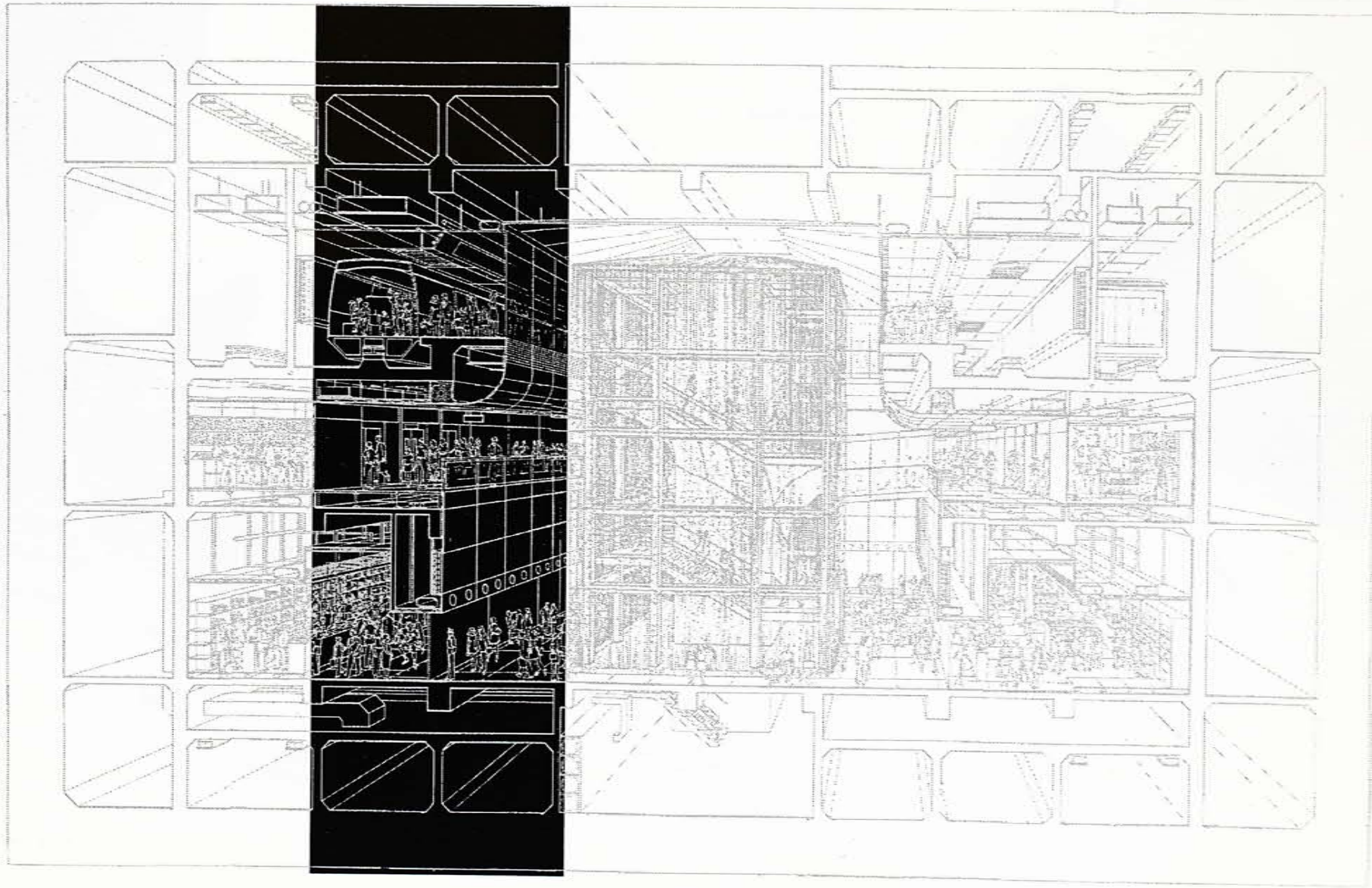


7.17 BUILDING CONCEPT

The pedestrian harbour crossing tunnel, actually, is a new building type and no previous example in Hong Kong or even in the world. However, the construction concept is quite similar to the vehicular harbour crossing tunnel. Also, in terms of building concept, it is quite similar to two highrise buildings lying down and connect their building top together. Put this example to the proposed pedestrian tunnel, it is interesting to find that the length of the tunnel is similar to the building height of China Bank building plus Central Plaza. As a result, in terms of circulation of people and cargo, also building systems can be used this case as an example to start generating building concepts.

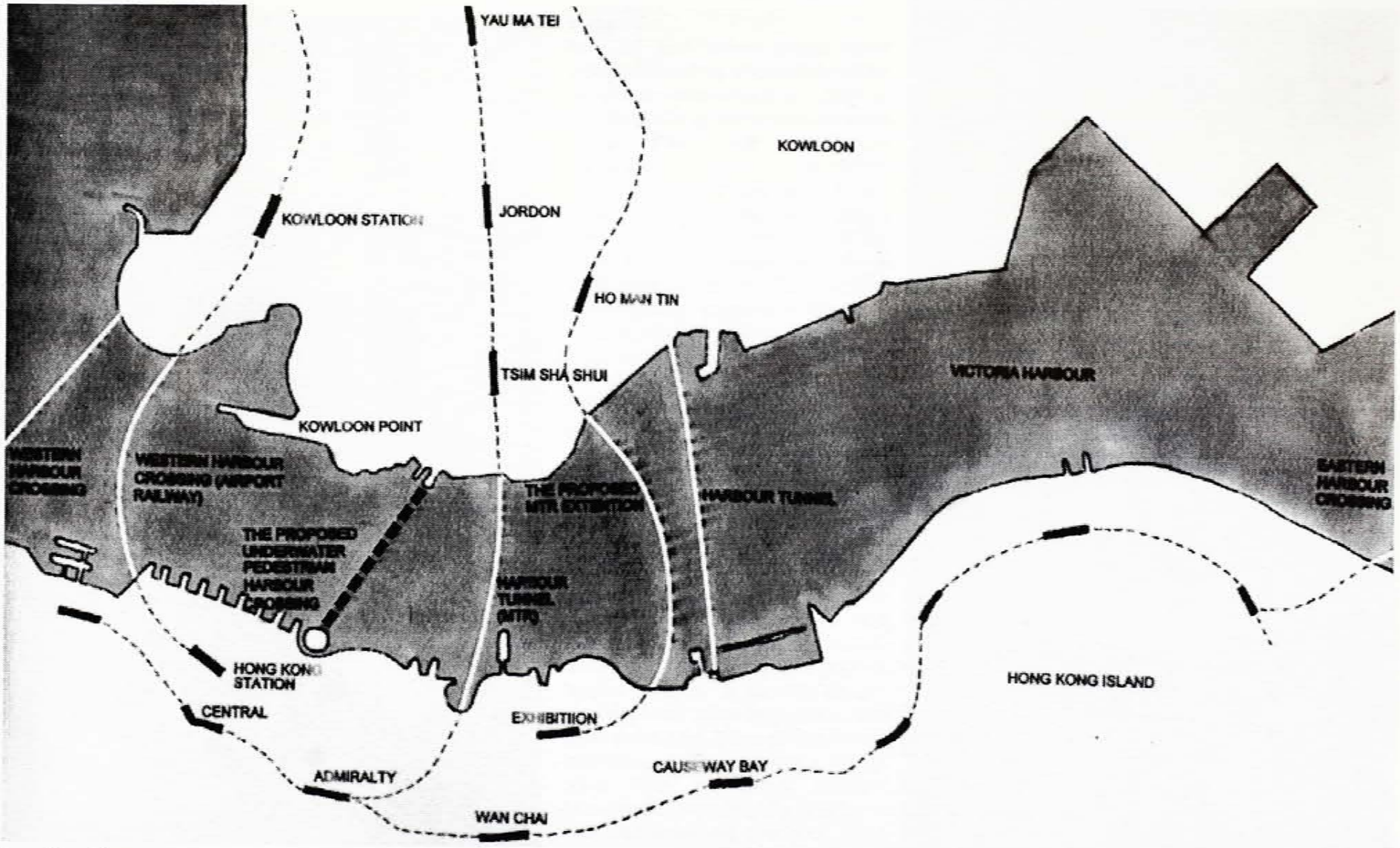


7.2 MASTER PLANNING



7.21 LOCATION

The proposed Underwater Pedestrian Harbour Crossing will start from the Star Ferry Pier at Tsim Sha Tsui and end in Central Basin at northern Hong Kong Island. The total length between the two places is about 1100m. The length of the proposed tunnel entrance at Tsim Sha Tsui and Central Basin is about 110m long respectively and the rest of the length, that is 880m is the underwater tunnel portion.



Location plan

7.22 SITE PLANNING (TSIM SHA TSUI)

Entrance plaza

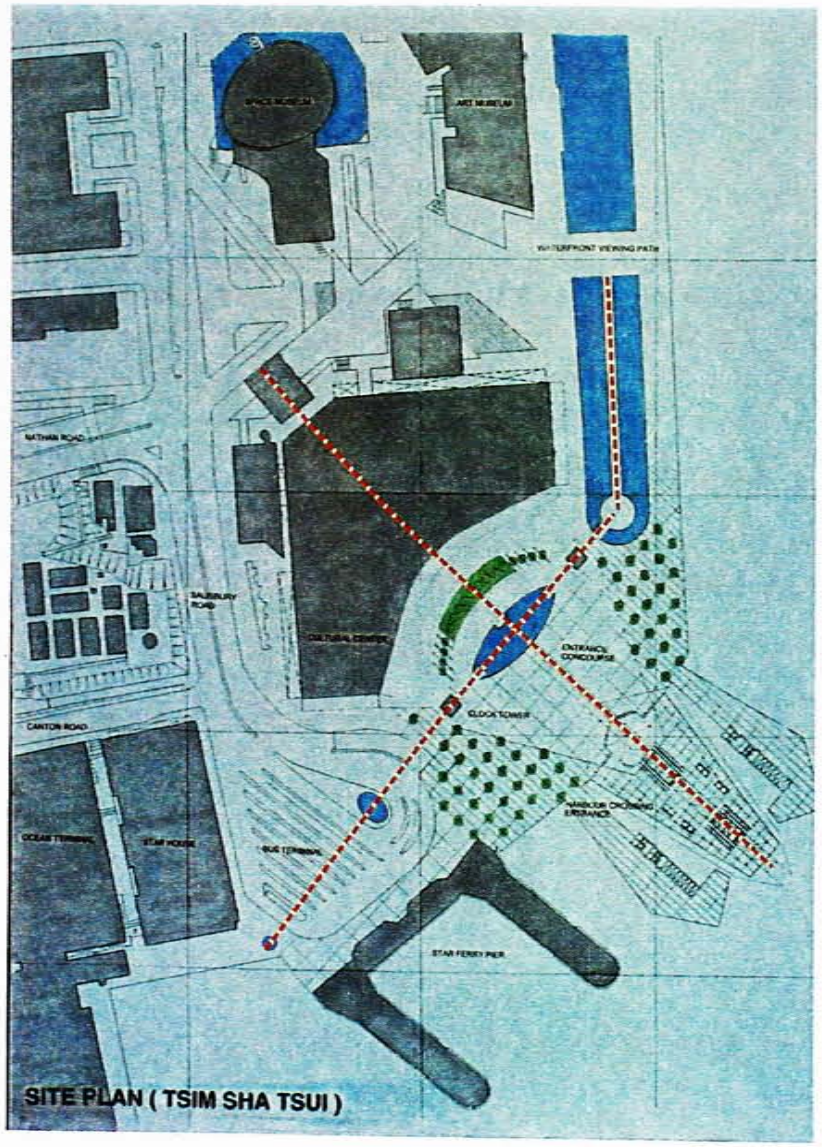
The proposed tunnel entrance will locate in front of the existing Cultural Center. Space between the tunnel entrance and Cultural Center will form an open plaza which will treat with both soft and hard landscape. This open space will serve as an entrance plaza for the tunnel entrance.

Axis

The master layout concept of the tunnel entrance, actually, is generated by two important axis. One is started perpendicular to the middle part of the Cultural Center and run across the entrance plaza and end in the middle part of the tunnel entrance building. The other axis is cut across the existing sculpture, pond and the Clock Tower which is perpendicular to the first axis. The two axis, as a result, form a square shape entrance plaza.

Waterfront viewing path

The waterfront viewing path is one of the feature in TST. However, the existing elevated viewing path along the shore line will be replaced by the proposed tunnel entrance. As a result, around the entrance, a new viewing path will be built and connect to the existing path and this important district feature can be kept and related to the new master layout design.



SITE PLAN (TSIM SHA TSUI)

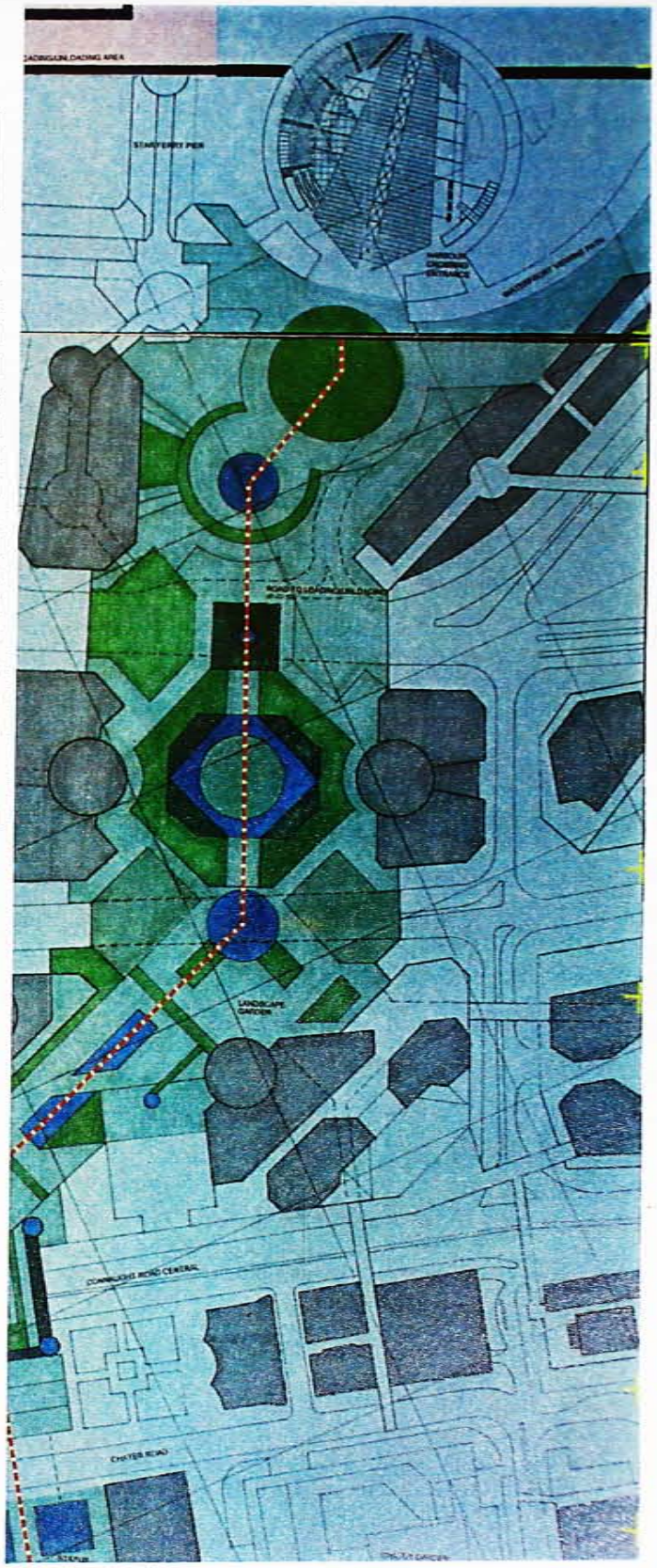
7.23 SITE PLANNING (CENTRAL BASIN)

Axis

One of the most important urban planning proposal in the future development of Central and Admiralty reclamation land is the elevated landscape garden. This elevated landscape garden will start from the existing Hong Kong Bank and end in Central Basin, that is the proposed tunnel entrance location. The garden will clearly separate Central and Admiralty physically. It will serve as a communal space for the two urban district. The proposed tunnel entrance will locate at the end of the axis.

Entrance plaza and waterfront viewing path

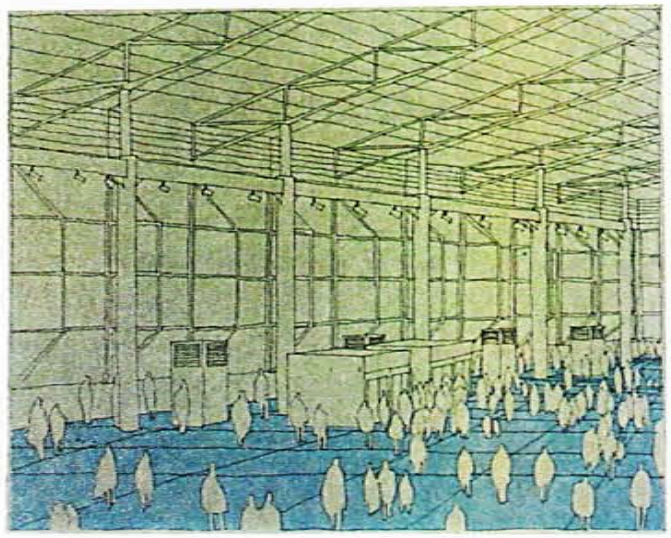
Similar to the master layout design of TST tunnel entrance, in Central Basin, the tunnel entrance will have a large open space in the front part and serve as an entrance plaza. Besides, following the curve basin shape, a circle shape waterfront viewing path will surround the tunnel entrance building. Both entrance plaza and the viewing path's treatment will highly relate to the surrounding context, that is the elevated landscape garden. As a result, the whole master layout design of the tunnel entrance will become part of the elevated landscape garden design.

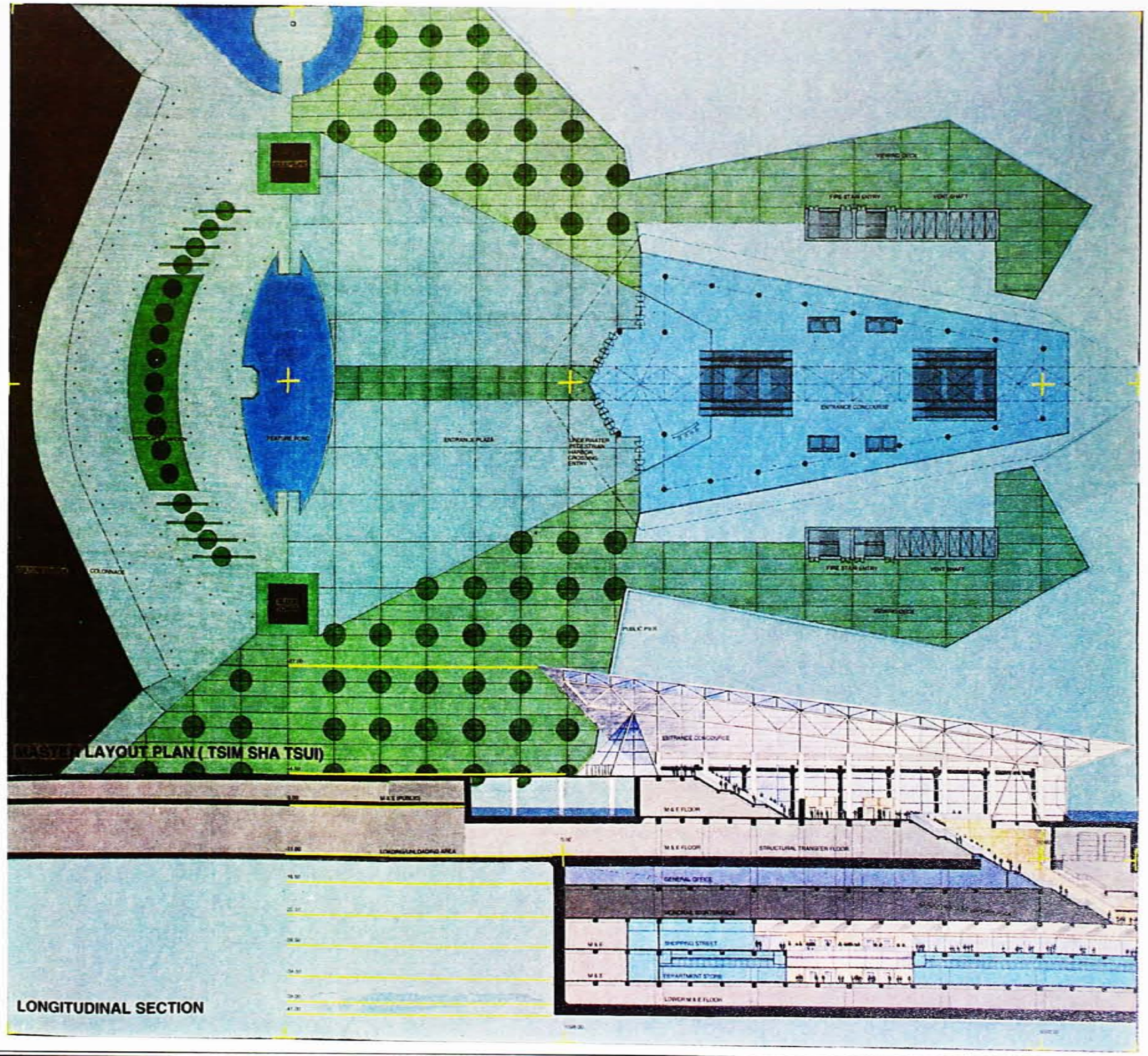


7.24 MASTER LAYOUT DESIGN (TSIM SHA TSUI)

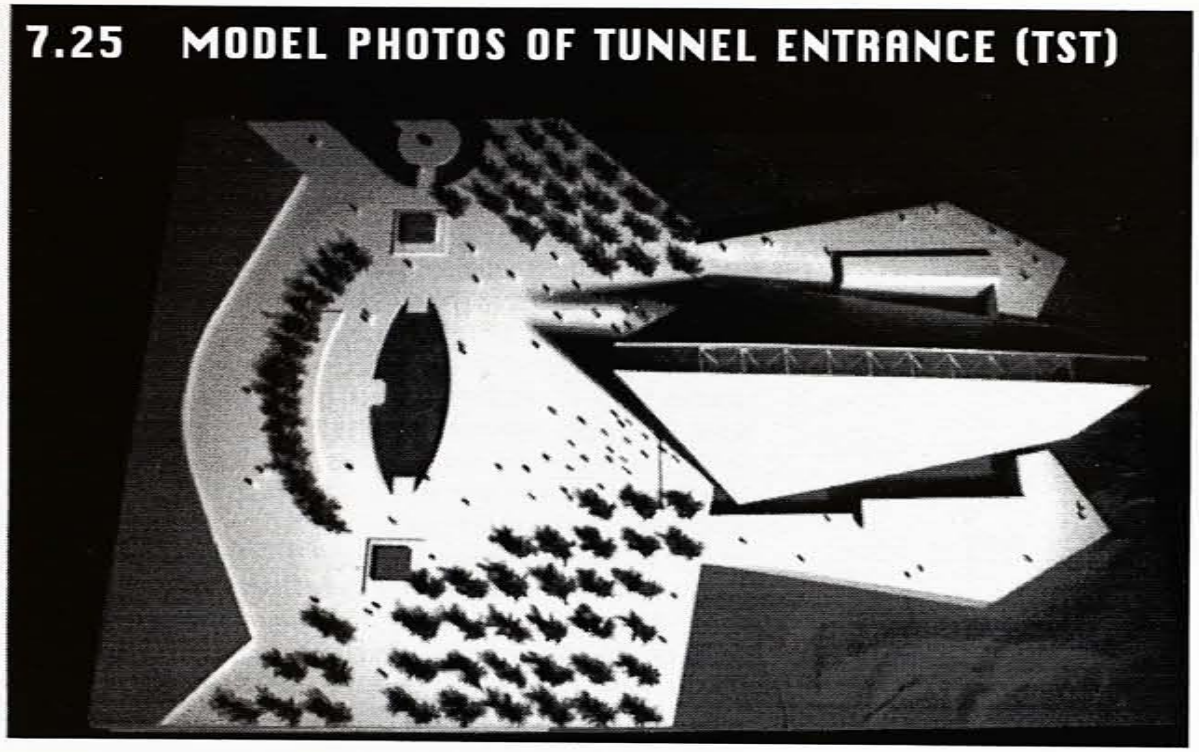
Building concepts

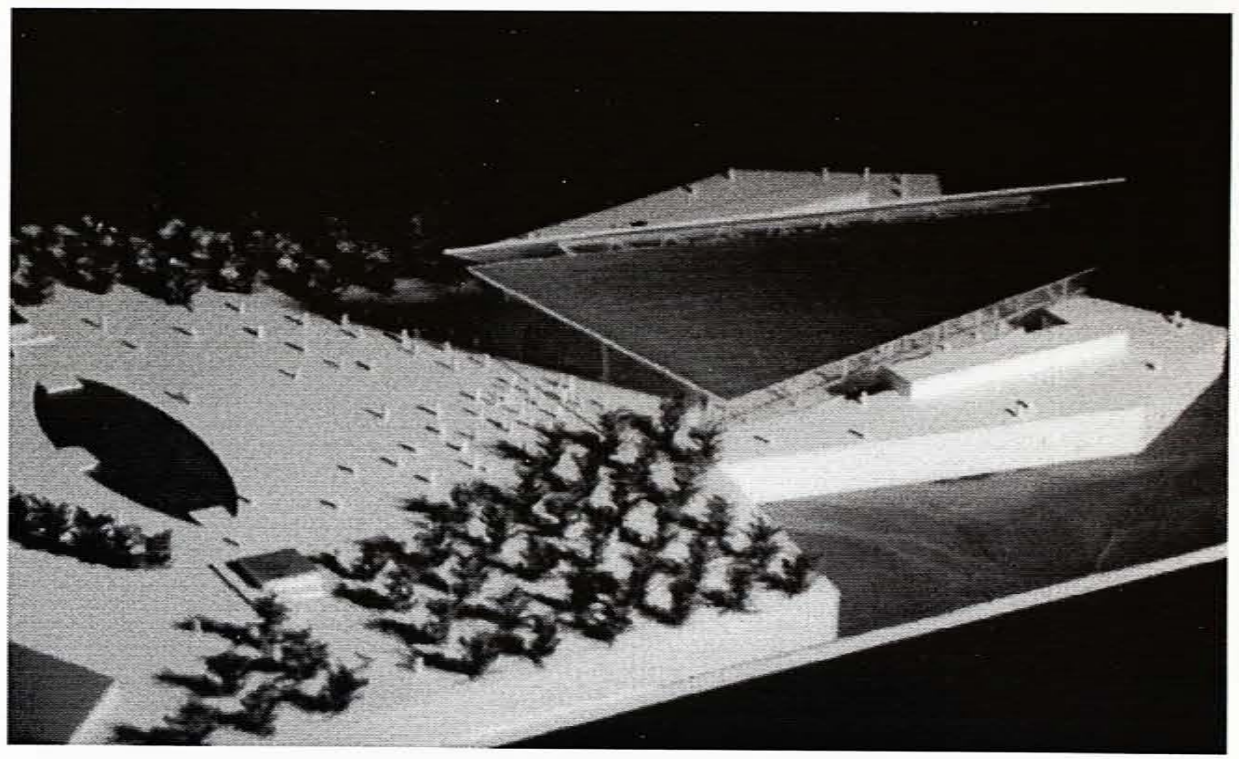
The tunnel entrance building is a triangular shape building. The building form is narrow down from the entrance to end of building. This shape creates a changing spacial feeling from very open to enclose when entering the building or from very enclose to open when leave the building. Besides, it is a highly transpanency building with large glazing panel at the building's two side. It allows daylight to enter the building and create quite a different spacial quality compare to the tunnel portion. As a result, people will experience different feeling between different part of the building and tunnel. Apart from these, water is another design feature. The whole entrance concourse is exractly sit at the sea level. This design lad people gain a feeling from land into underwater when enter from building outside to the entrance concourse. Furthermore, water is not just at the two sides of the building. On the roof top level, between the two roofs is a channel with water curtain start from roof top to the end of the building. As a result, a three-dimensional water feature is created in the entrance concourse space. The entrance concourse links up the tunnel and the entrance plaza. People can either use escalators, stair or lifts to enter the tunnel portion from entrance concourse.

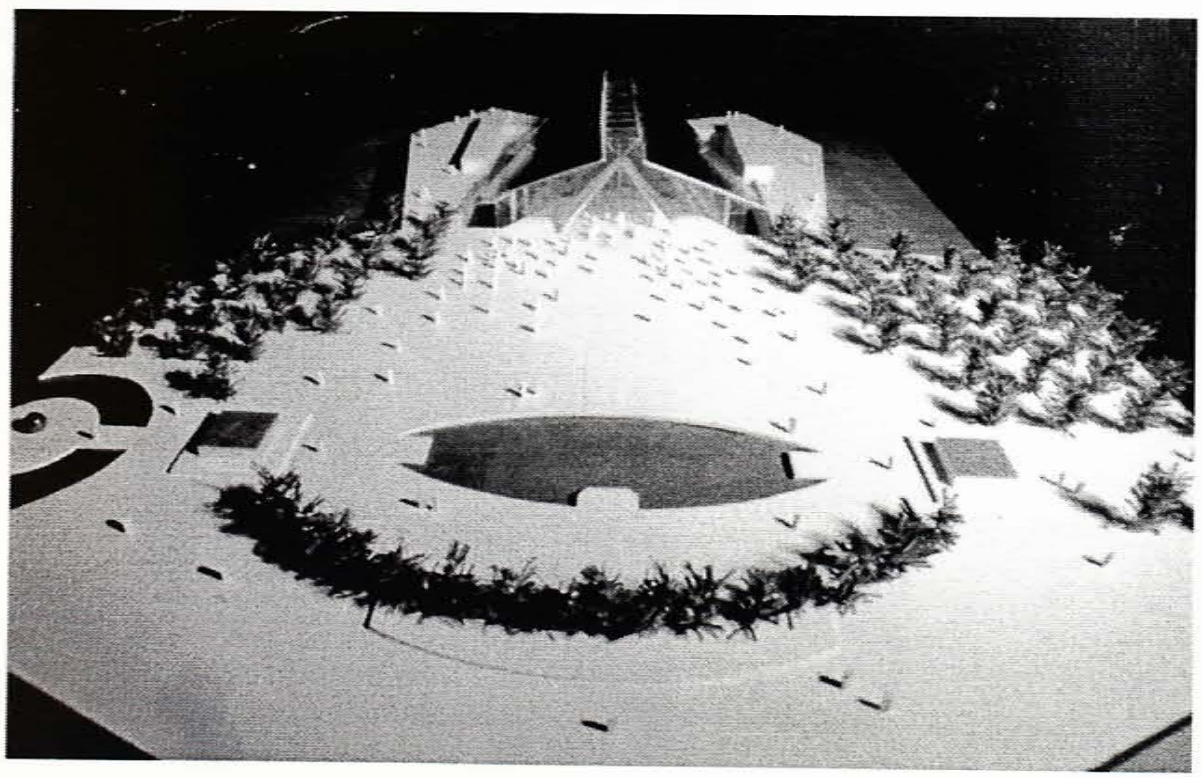


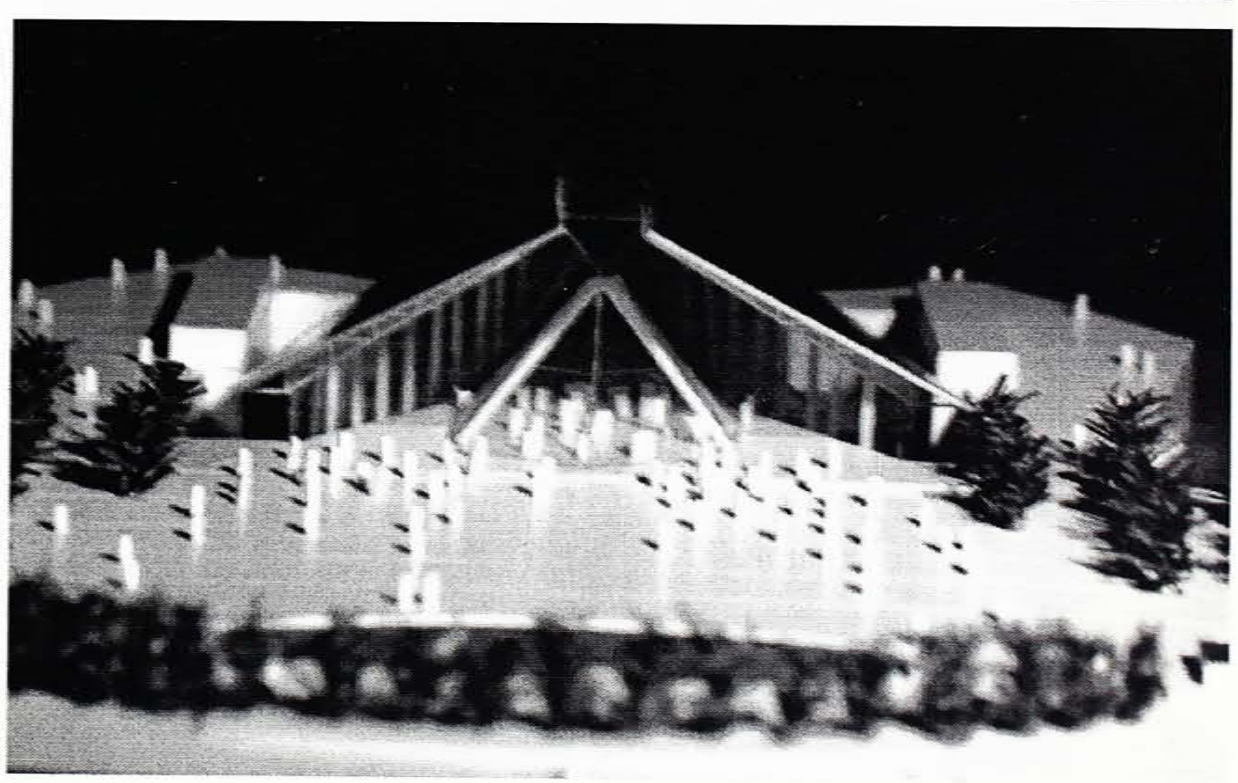


7.25 MODEL PHOTOS OF TUNNEL ENTRANCE (TST)





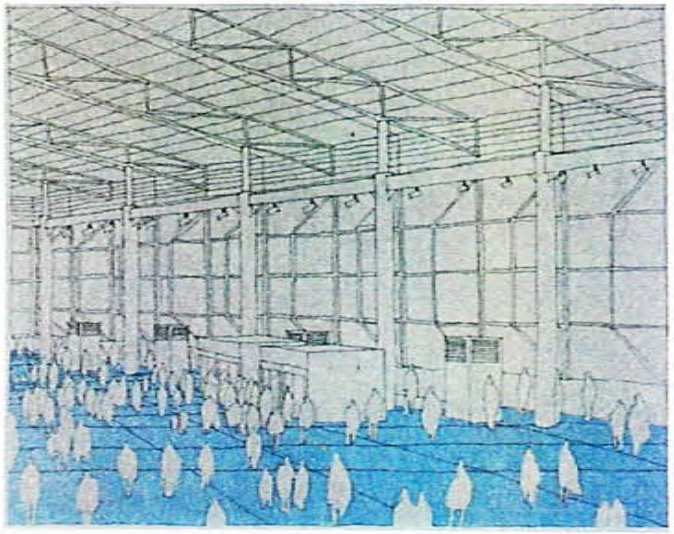


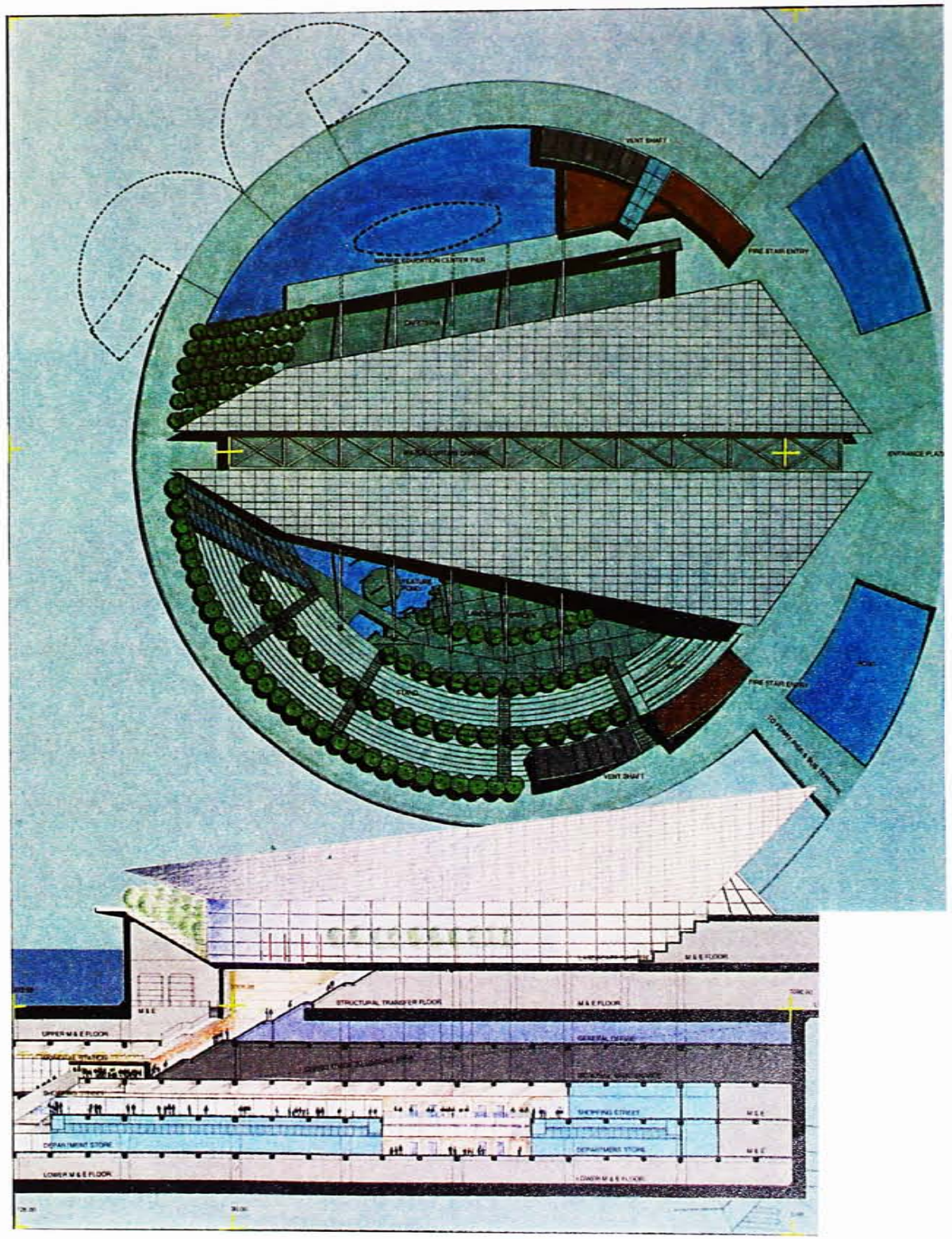


7.26 MASTER LAYOUT DESIGN (CENTRAL BASIN)

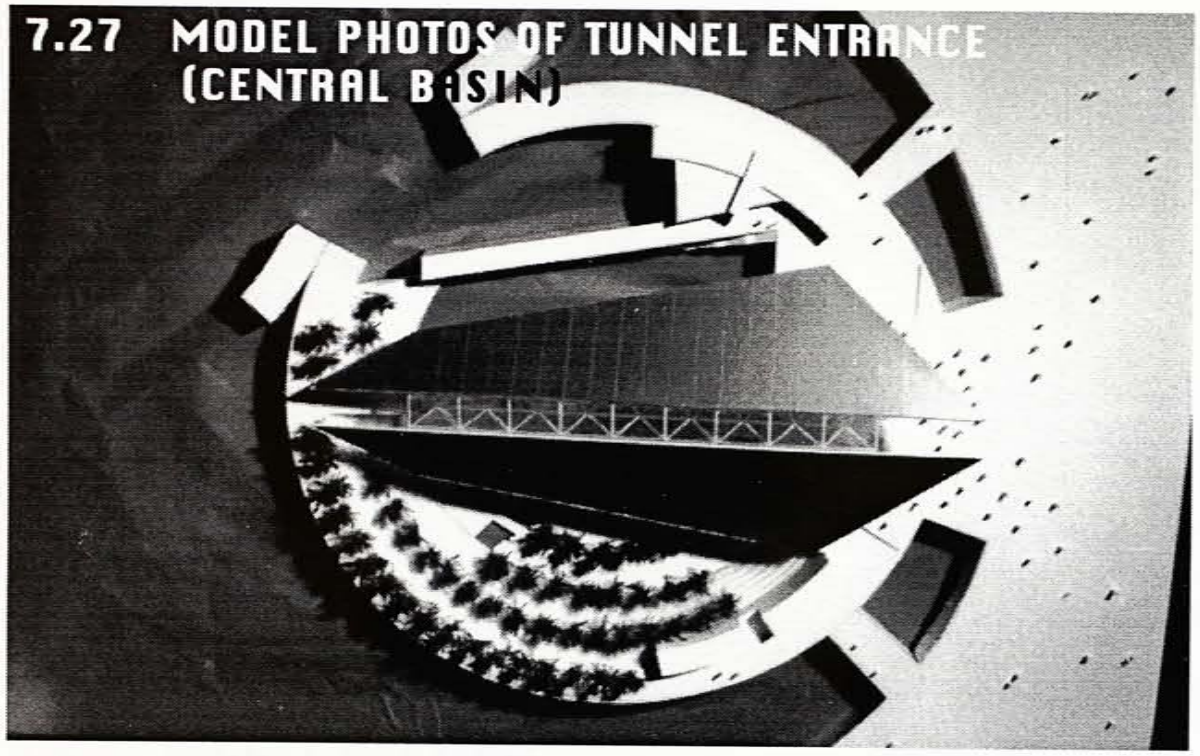
Building concepts

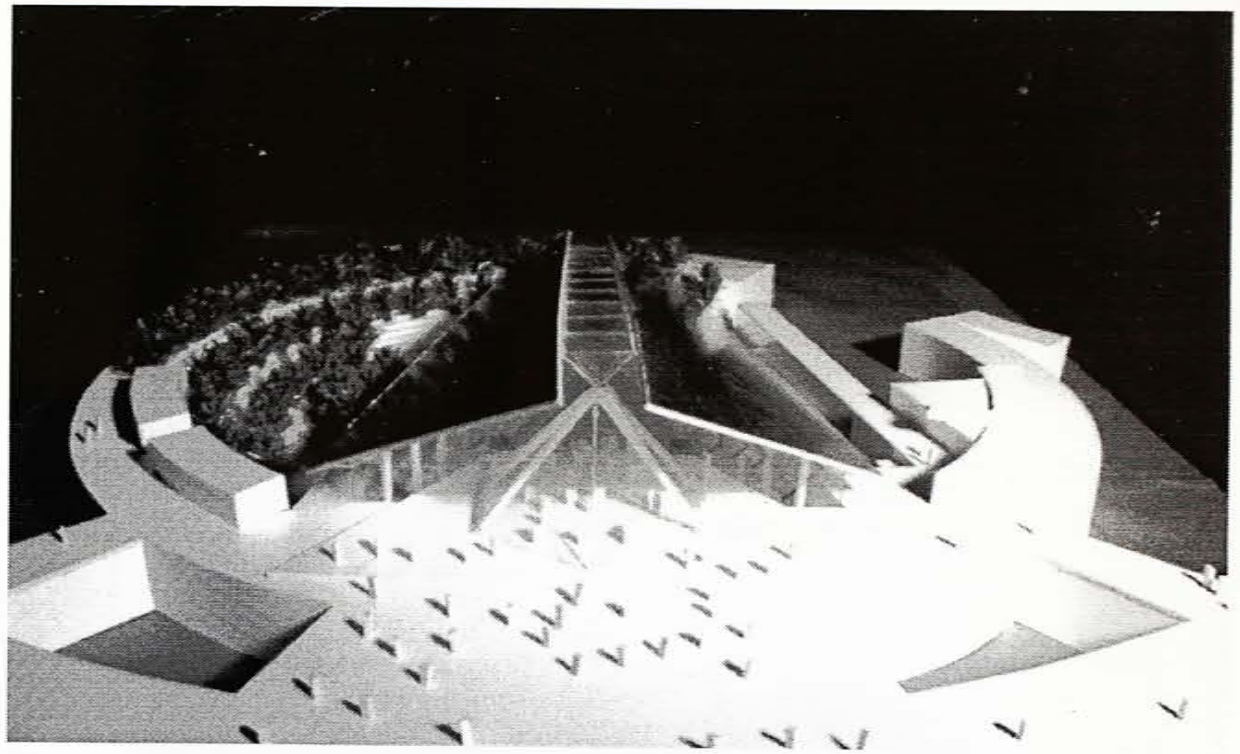
The tunnel entrance building at Central Basin is similar to Tsim Sha Tsui; the only different is the building's surrounding treatment. As the tunnel entrance is located at a curve shape's shore line, the waterfront viewing path which surrounded the building is design to echo the shore line shape. As a result, a circle shape viewing path is formed and the entrance building is sit in the middle of this circle. Besides, the building's location divides the circle into two spaces. Different treatments are used in these two spaces. The eastern part of the building is a ferry pier which is internally used by the marine education center. A cafeteria is located underneath the ferry pier with large glazing panel enclosed so as to get the underwater view. The western part of the entrance building has an open stand. The upper part of the stand is the ground level and the lower part of the stand is the tunnel entrance concourse level. A small landscape garden is also located at the lower level which connected the concourse and the stand. Trees are planted around the stand and lad the whole space to echo the elevated landscape garden that located next to the tunnel entrance. Although the two entrances have the same building design, different spacial feeling is still achieved.

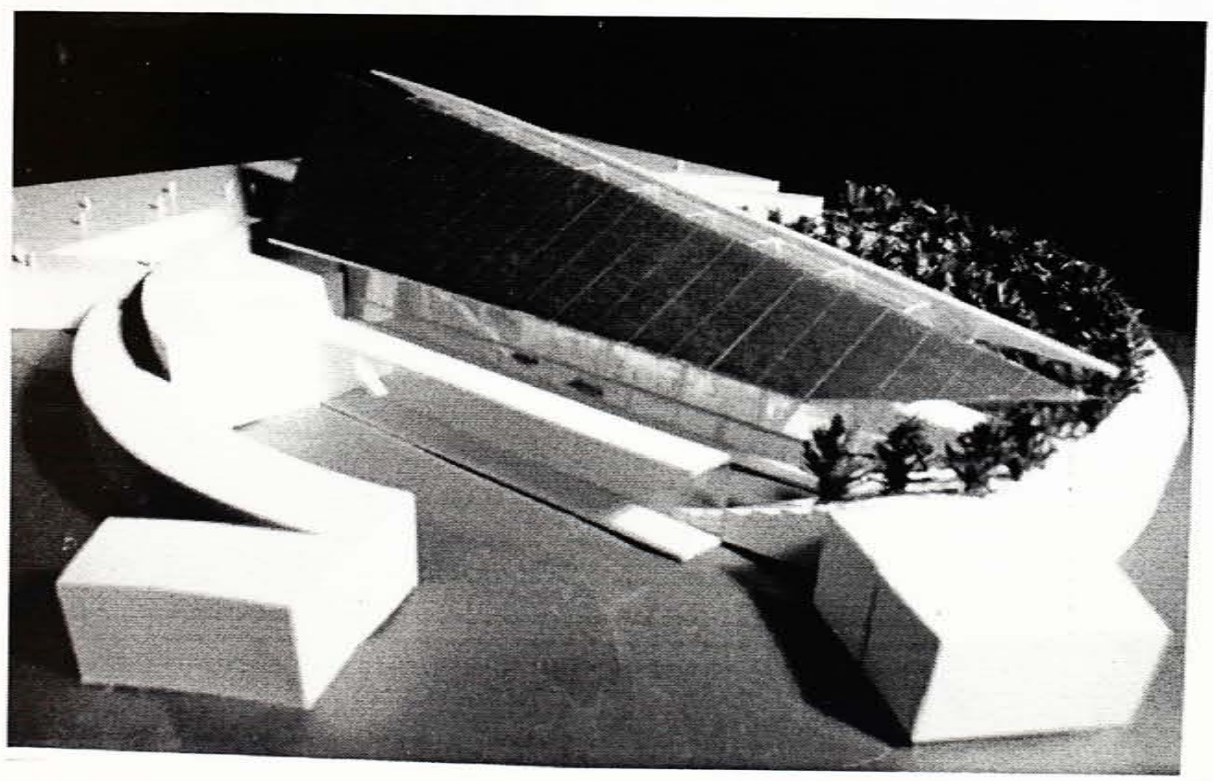


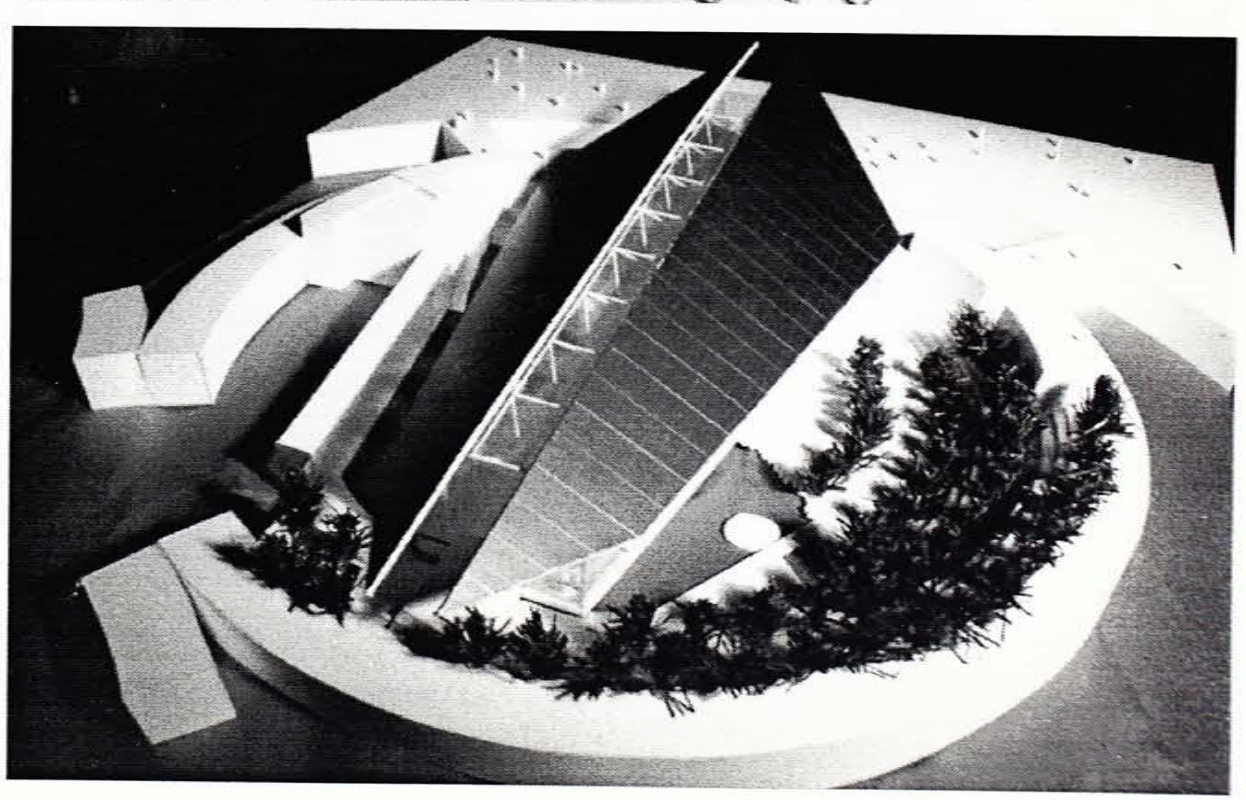


7.27 MODEL PHOTOS OF TUNNEL ENTRANCE (CENTRAL BASIN)

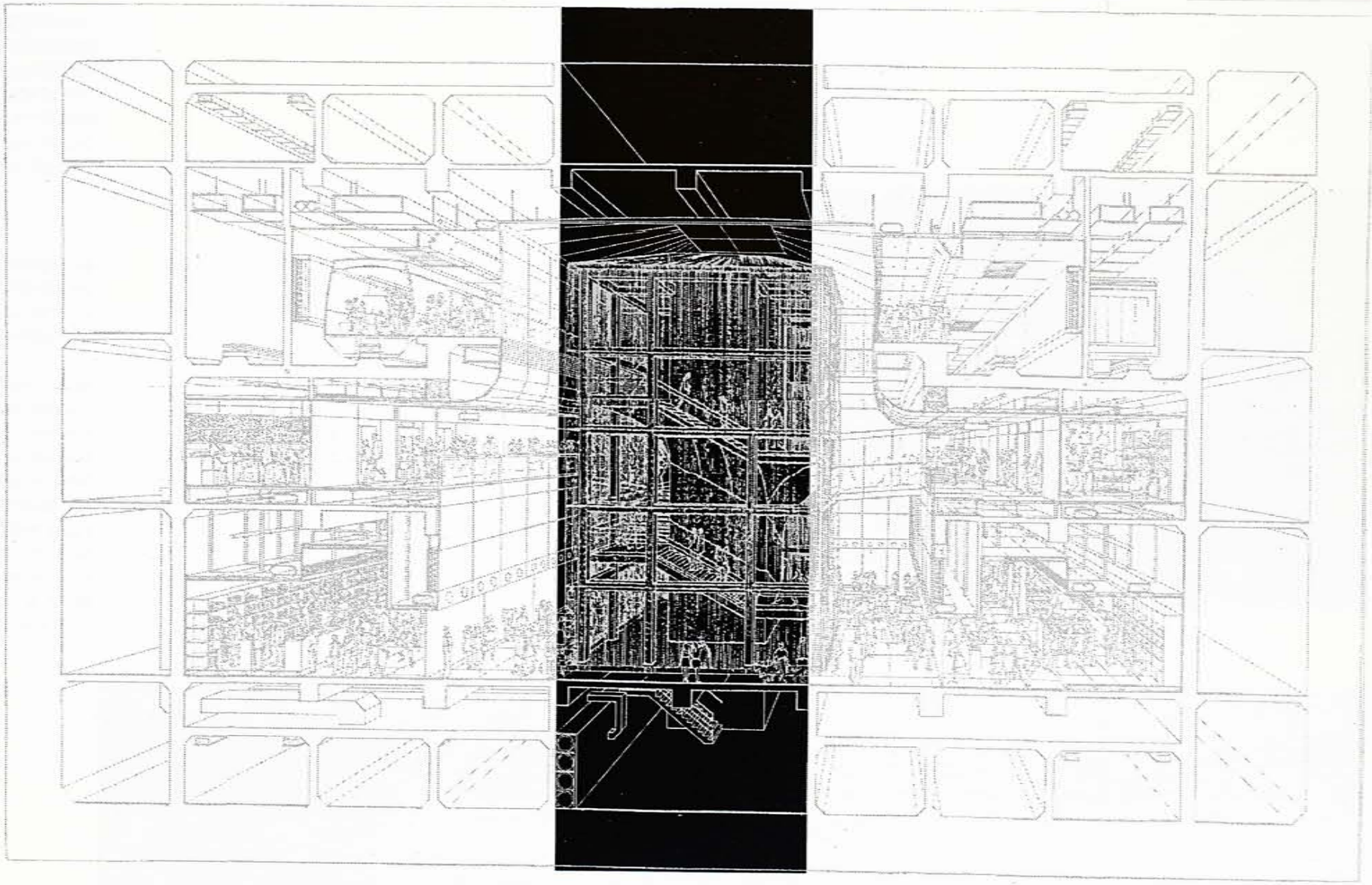








7.3 TUNNEL PORTION



SHOPPING STREET (SECTION 1, 2, 8)

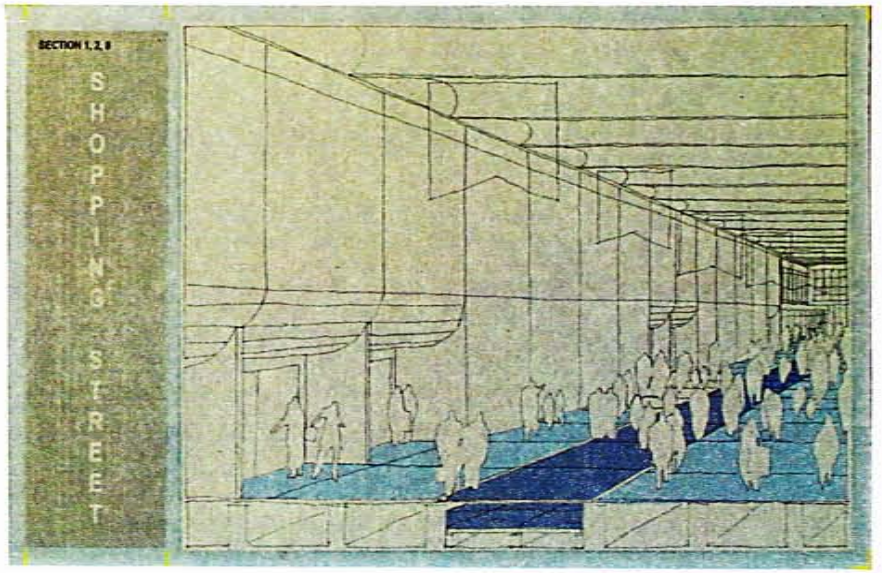
The built form of the tunnel

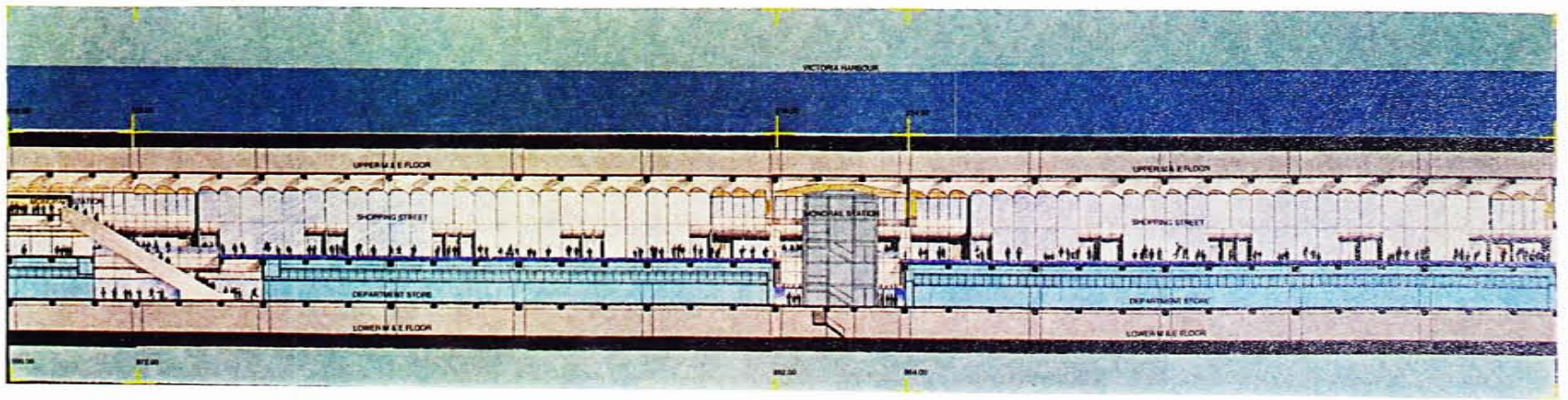
The tunnel has a retangular box shape with structural steel and concrete enclosure as its superstructure. The design process of the tunnel form is dorminated by its construction method and the building services integation instead of starting from an architectural, spacial or formal concept. The length of the tunnel portion is 864m long. It is divided into 8 sections and each section is 108m long. The width of the tunnel is 49m and the height is 30m.

The organisation of the tunnel

The enclosure of the tunnel is a 2m thick concrete wall with structural steel inside. The periphery of the tunnel houses all the building systems and the inner remaining space is served as the program space.

The tunnel is divided into 5 levels. The highest and the lowest level are mechanical floor which house all the e & m spaces, air vnet shafts, escape routes and other building services. The other three levels are the program space. A 18m organisation and structural grid is applied throughout the tunnel. It creates a 18m column free space in the middle part throughout the tunnel. Besides, the two sides of the tunnel have a 4m width's spaces which house all the vertical services like cargo lifts, fire stairs, e & m rooms. A 0.5m thick structural wall is separated this zone and the inner space of the tunnel.





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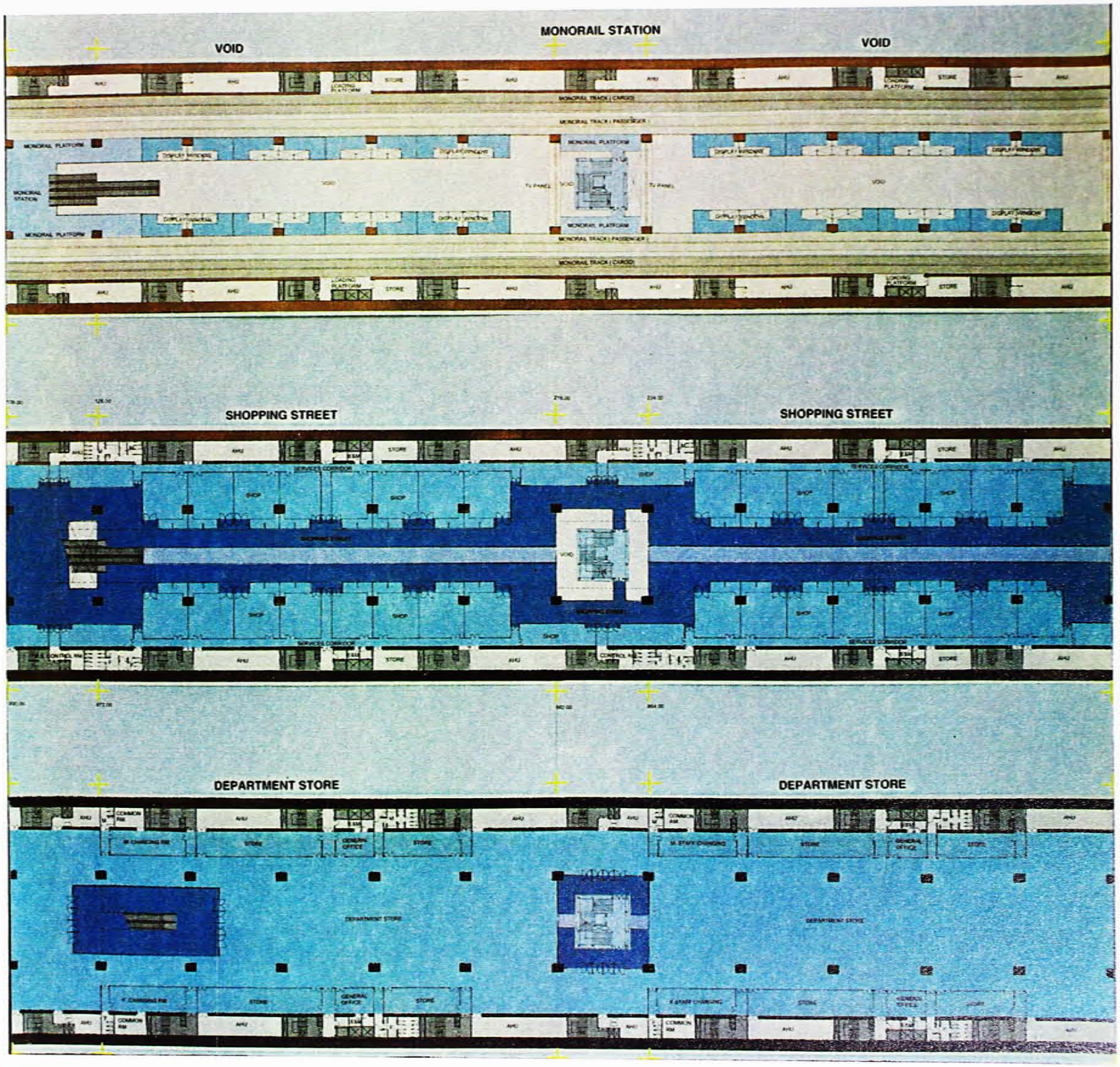


GAME WORLD (SECTION 3)
AQUARIUM (SECTION 4, 5)

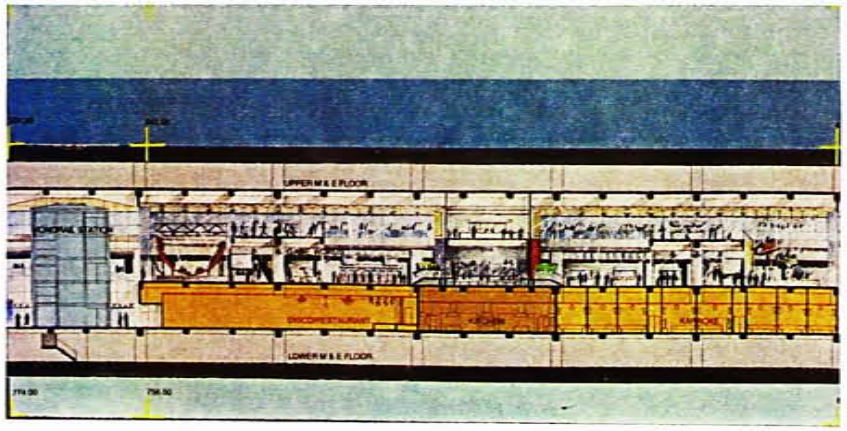
Organisation of building services

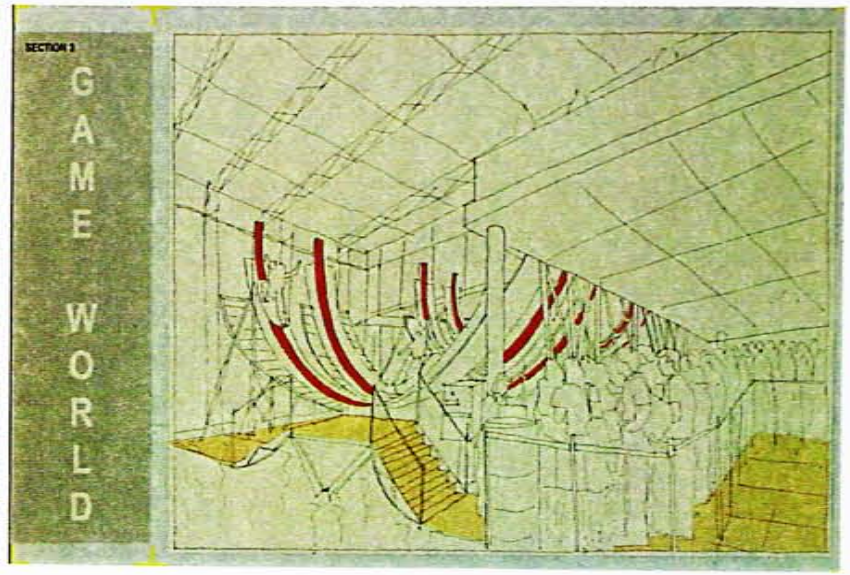
The organisation of the building services is the key part of the layout of the tunnel profile. The most important services in the tunnel are air ventilation, fire services, transportation systems for both passenger and cargo.

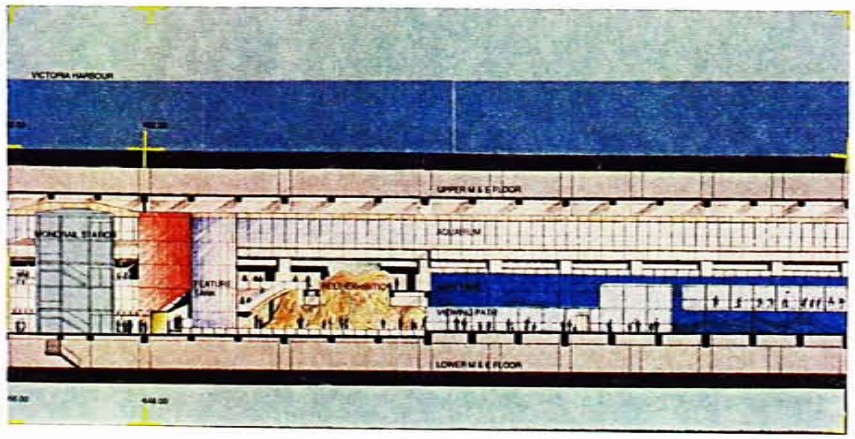
Air ventilation system is formed by air vent shafts. All air vent shafts are run through the whole tunnel portion and connect to the two end to extract unwanted air out and bring fresh air in. There are totally 4 supply air vent shafts and 4 exhaust air vent shafts. The supply air vent shafts are located at the lower mechanical level and the exhaust air vent shafts are located at the upper mechanical level. Fan rooms with high speed fan jets are located next to the vent shafts to maintain reasonable speed of air.

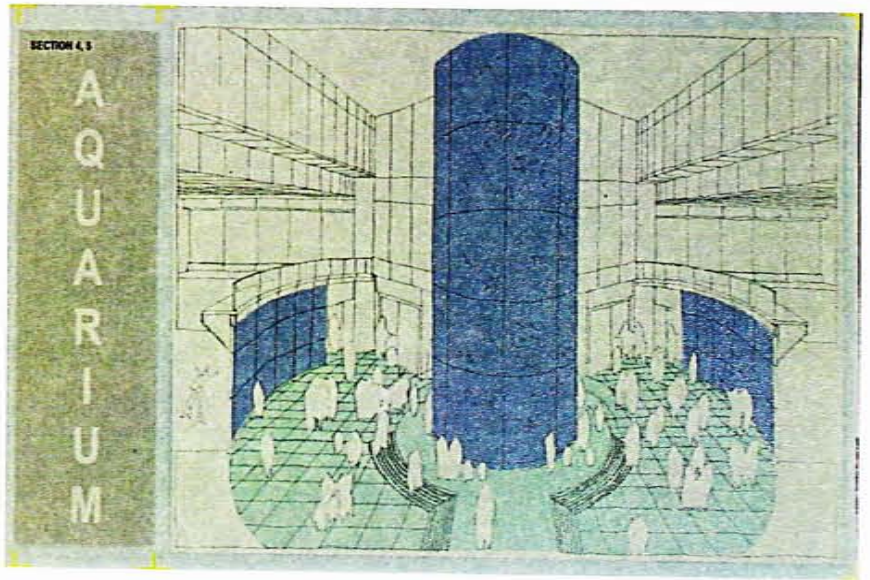
4 escape routes are located at the tunnel corners. All the routes are connected to fire stairs which located at the side vertical services zone. The middle part of upper and lower mechanical level house other building services. Upper level mainly houses ahu rooms, water tanks, fan rooms; lower level mainly houses e & m rooms, fan rooms and ahu rooms.

2 pairs of monorail systems are run through the whole tunnel portion. They are located at level 3. One is cargo monorail and the other is for passenger. All cargo monorail stations are located at the middle part of each section and the passenger monorail stations are located at the transactional zone between the section. As a result, the distance between the stations is 90m.









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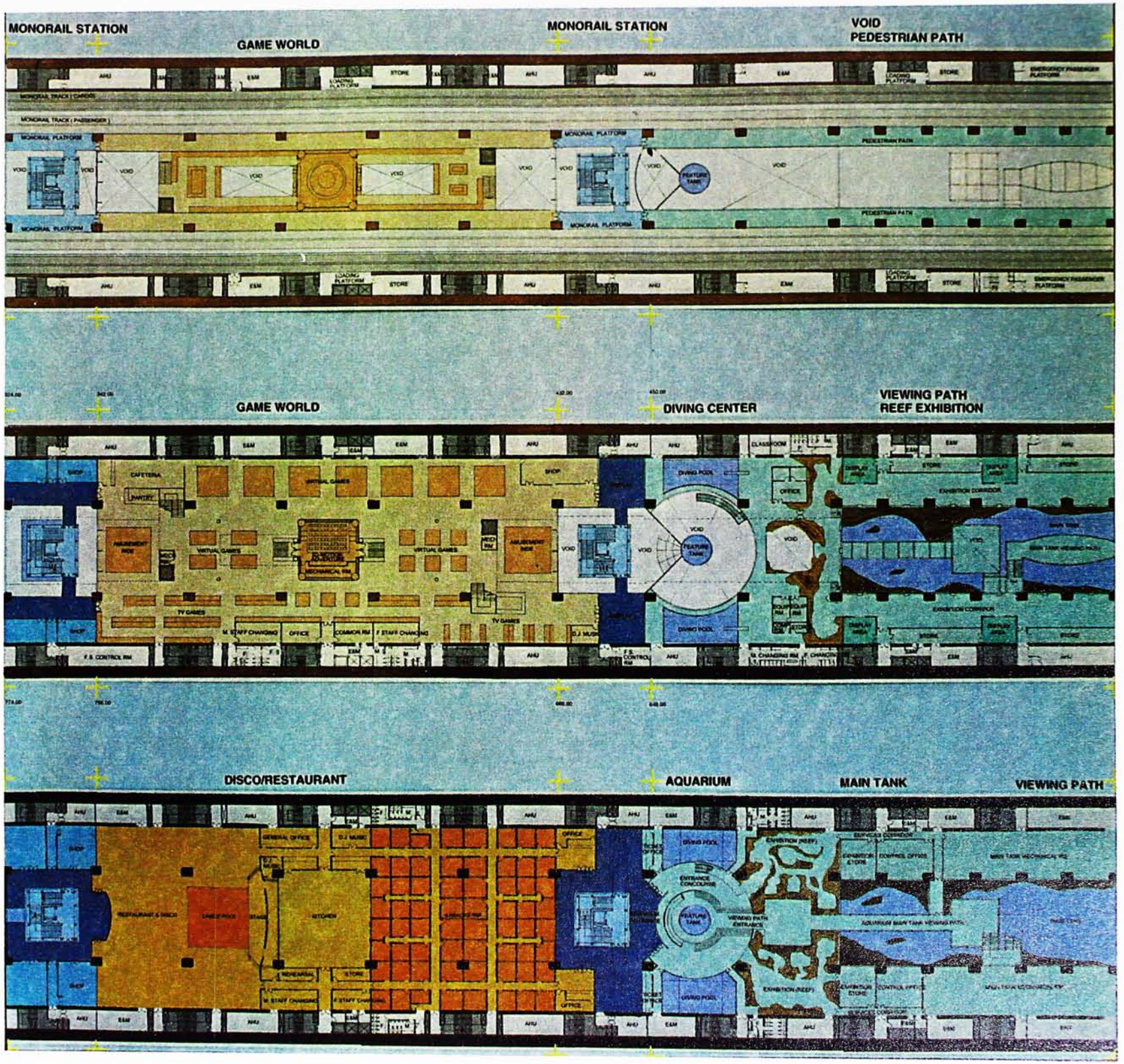
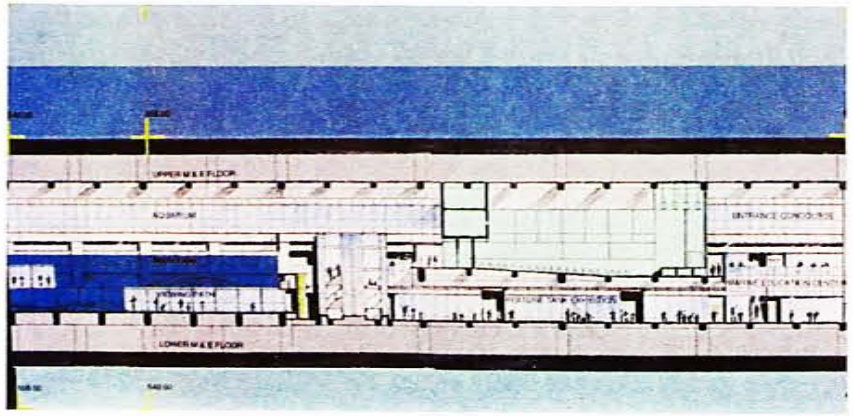
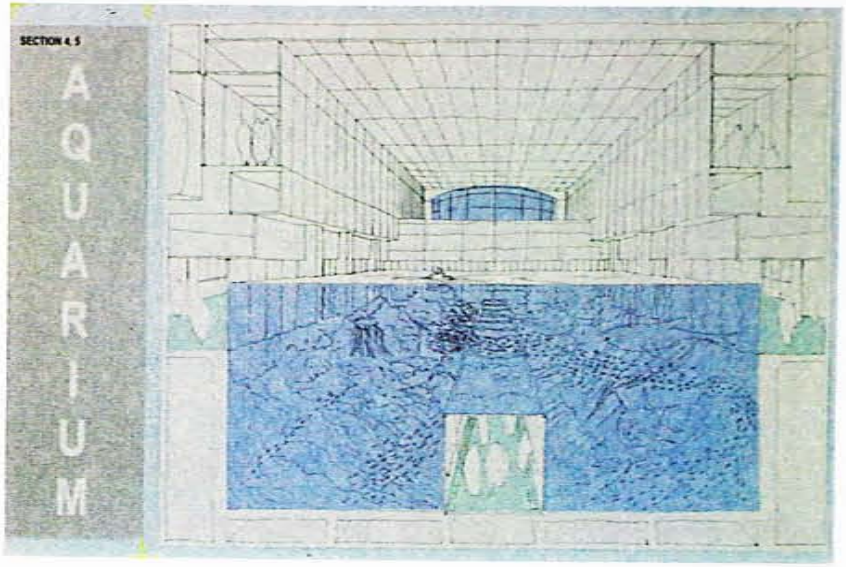


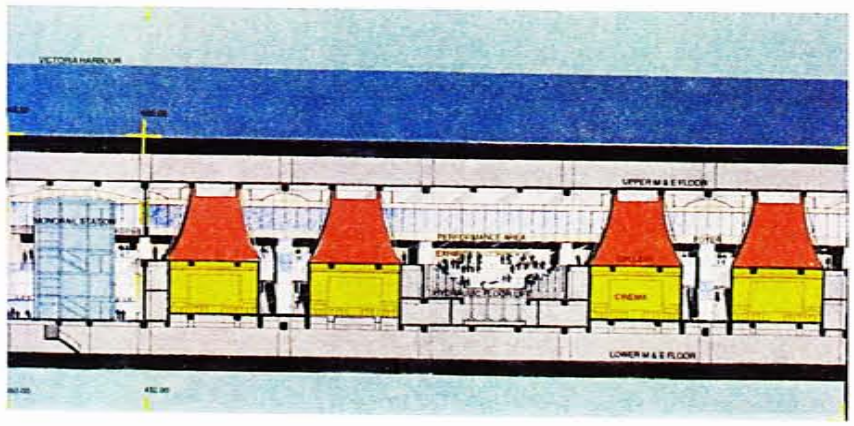
AQUARIUM (SECTION 4, 5)
CINEMA & GALLERY (SECTION 6)

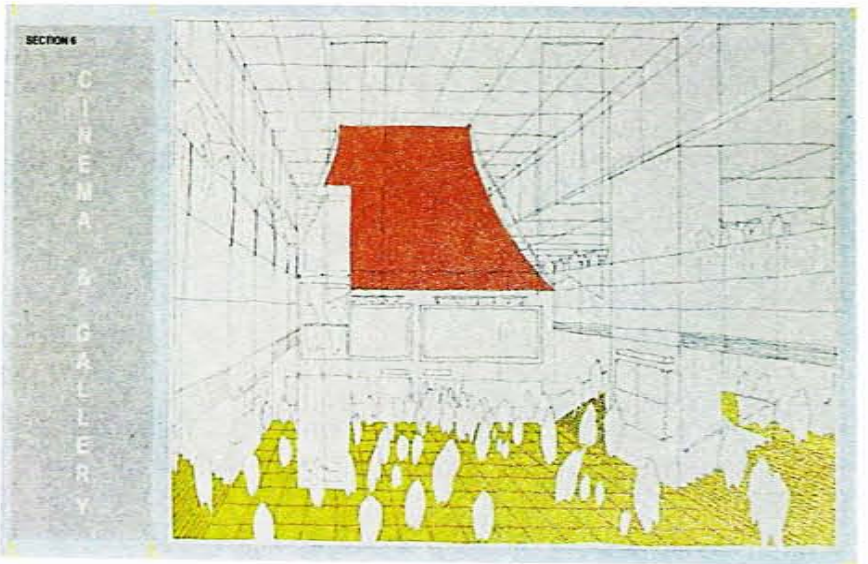
Functional organisation of the tunnel

The whole tunnel is divided into 8 sections. Different sections have different functions and the organisation of building function is mainly dorminated by the pedestrian flow of the tunnel. Similar to typical highrise commercial buildings or shopping arcades, the lower part of the building has high commercial value due to the high pedestrian flow. As a result, in those building types, the lower floors always locate retail shops. The upper floors are housed functions which are more static in terms of activities and pedestrian flow like game centers, restaurants, cinemas and so on. The functional organisation of the proposed tunnel is following this rule. So, the first 2 sections in Tsim Sha Tsui and the first section in Central Basin houses shopping streets and department stores. Following the shopping street is the game world in Tsim Sha Tsui side and food street in Cental Basin side. The middle part of the tunnel houses an aquarium and marine education center. The aquarium occupies 2 sections and next to it is cinema & gallery. So the final function sequence from Tsim Sha Tsui to Central Basin is shopping street, game world, aquarium, cinema & gallery, food street, shopping street.









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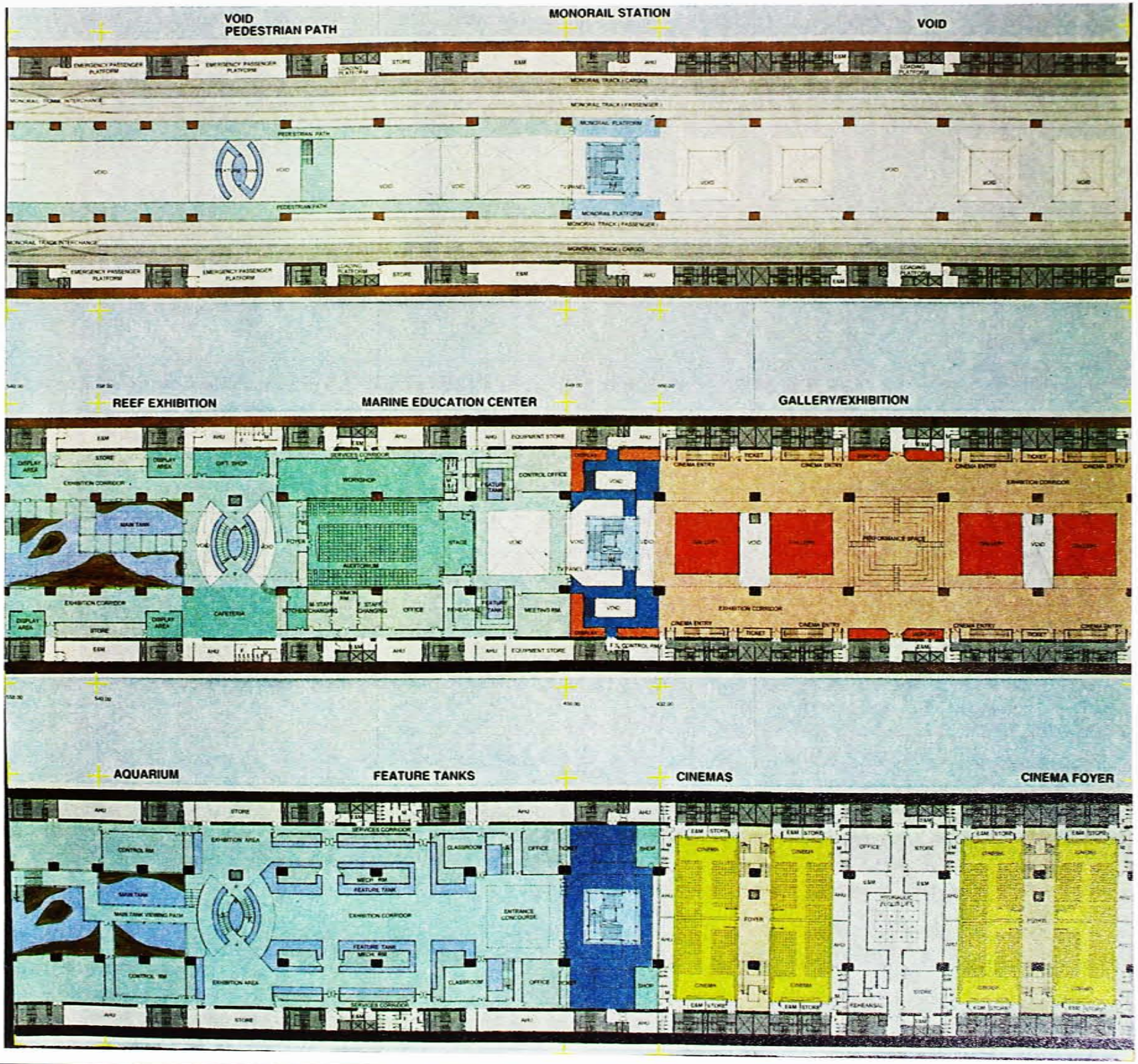
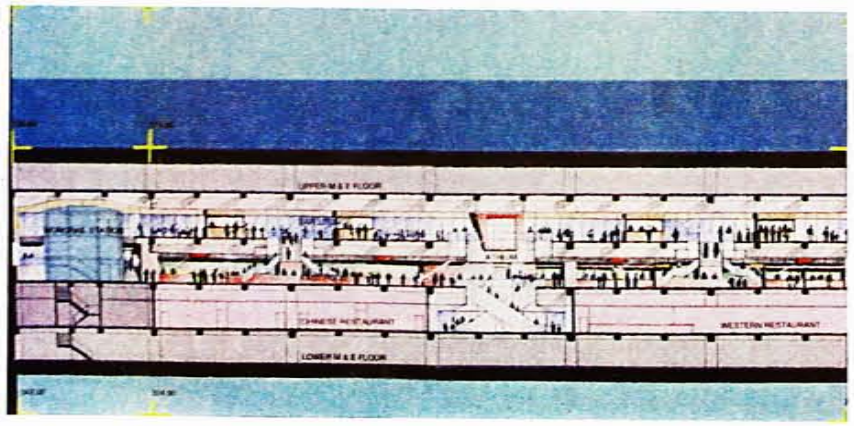


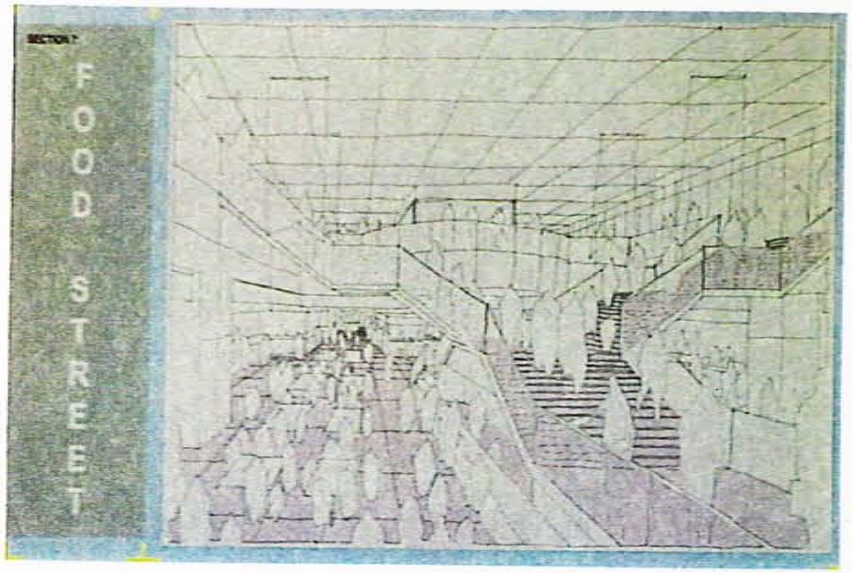
FOOD STREET (SECTION 7)
SHOPPING STREET (SECTION 1, 2, 8)

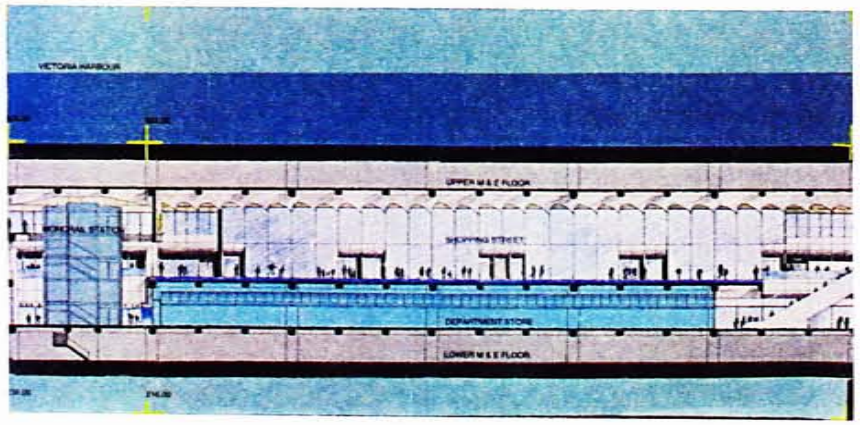
Spacial concepts

As different sections have different functions, each section has its own spacial character and create a variety of spacail feeling. Throughout the whole tunnel, water will be an important element in the creation of special spacial feature and to tide up all the different sections. As a result, water features like water curtain will find not only in the two entrance concourses but also in all transactional zones between the sections. Water curtain is enclosed all the stair tower, people inside the stair tower will see the outside scene with a layer of water and an image of underwater is created. Besides, water channel is located right in the middle of the shopping street. It allows people in shopping street 'walk' on the water and lad the shopping atmosphere more interesting.

In order to avoid an endless, long and narrow's typical tunnel space, the connection between each section is design as a gateway with TV wall surround so as to make an attractive and clear stop in terms of spacial quality in each section instead of a prolonged space. Furthermore, the floor to floor height in each program space floor is 6m, which is higher than normal building. As a result, a more open feeling's space is created rather than a narrow and enclosed space. So, two storey atrium spaces are commonly found in many sections like shopping street, game world, entrance concourses of aquarium, food street and so on.







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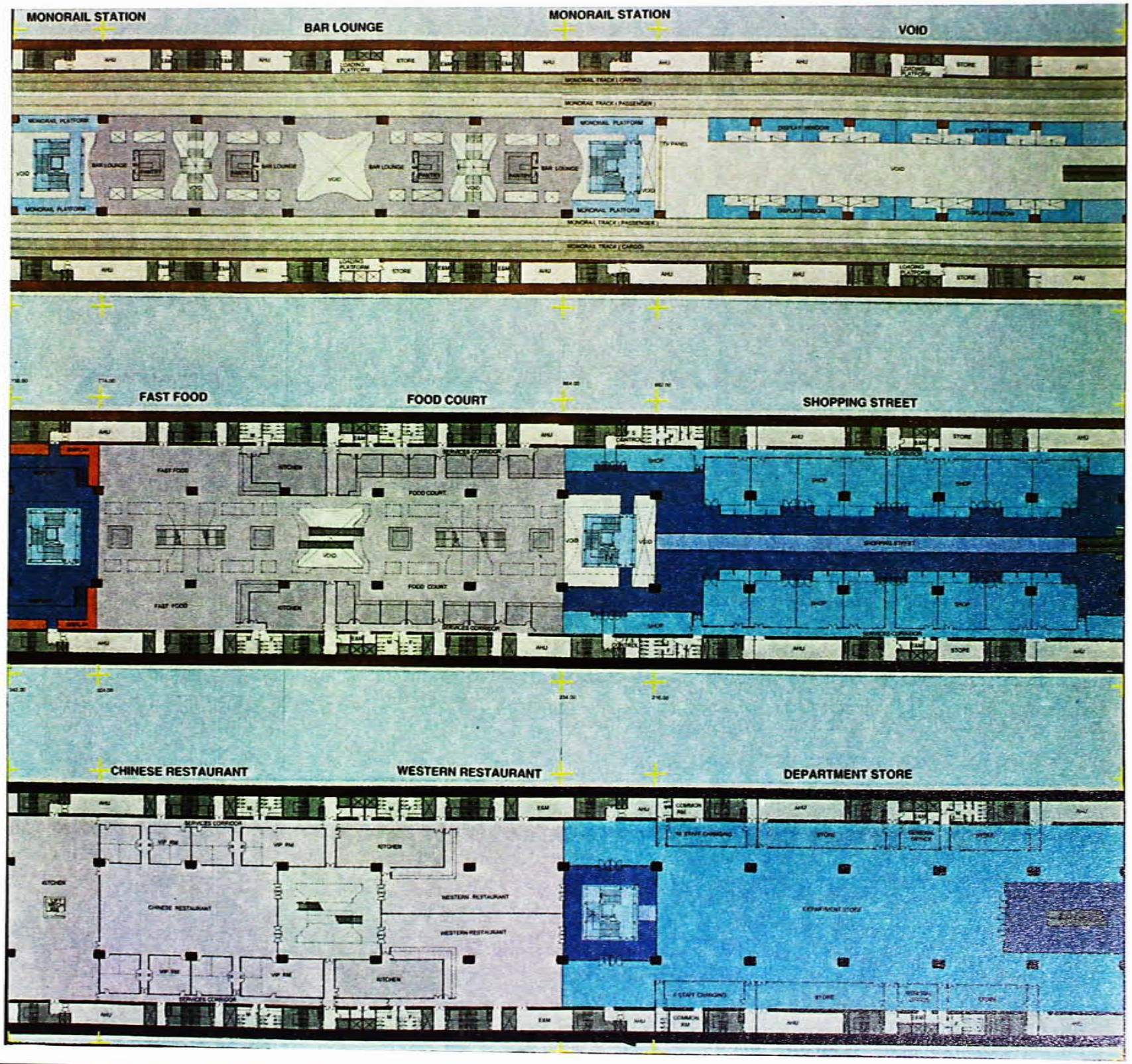
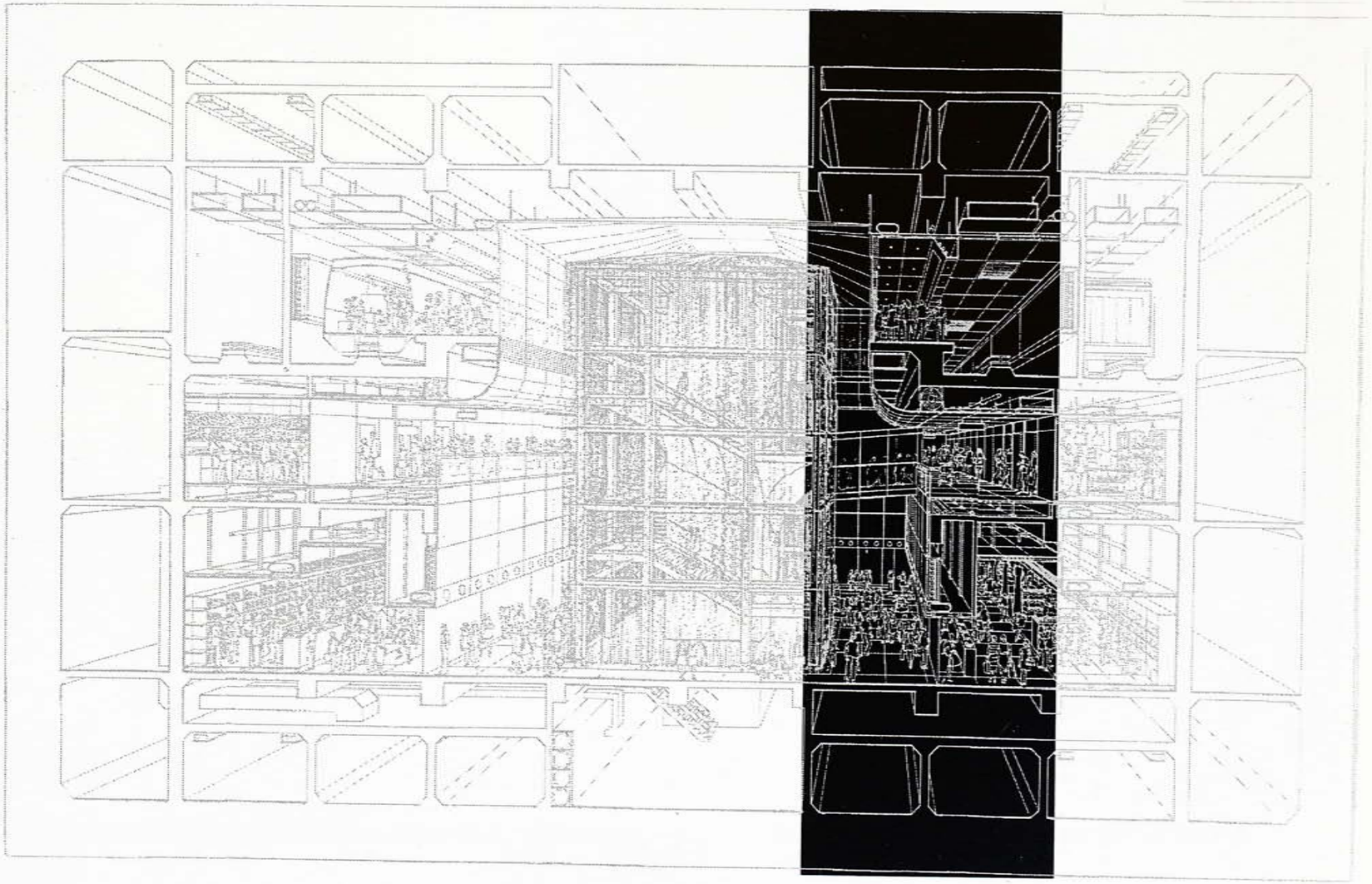
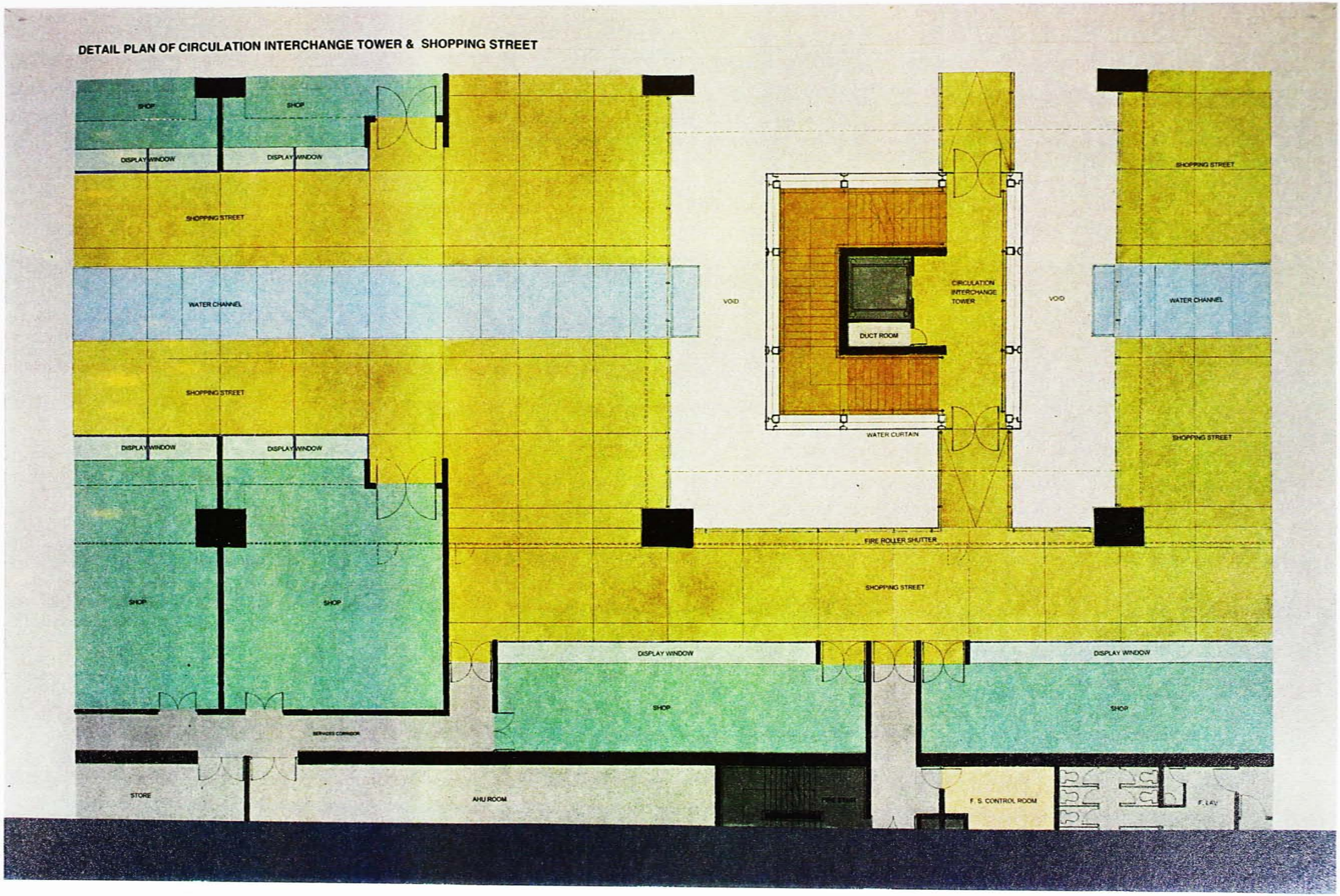


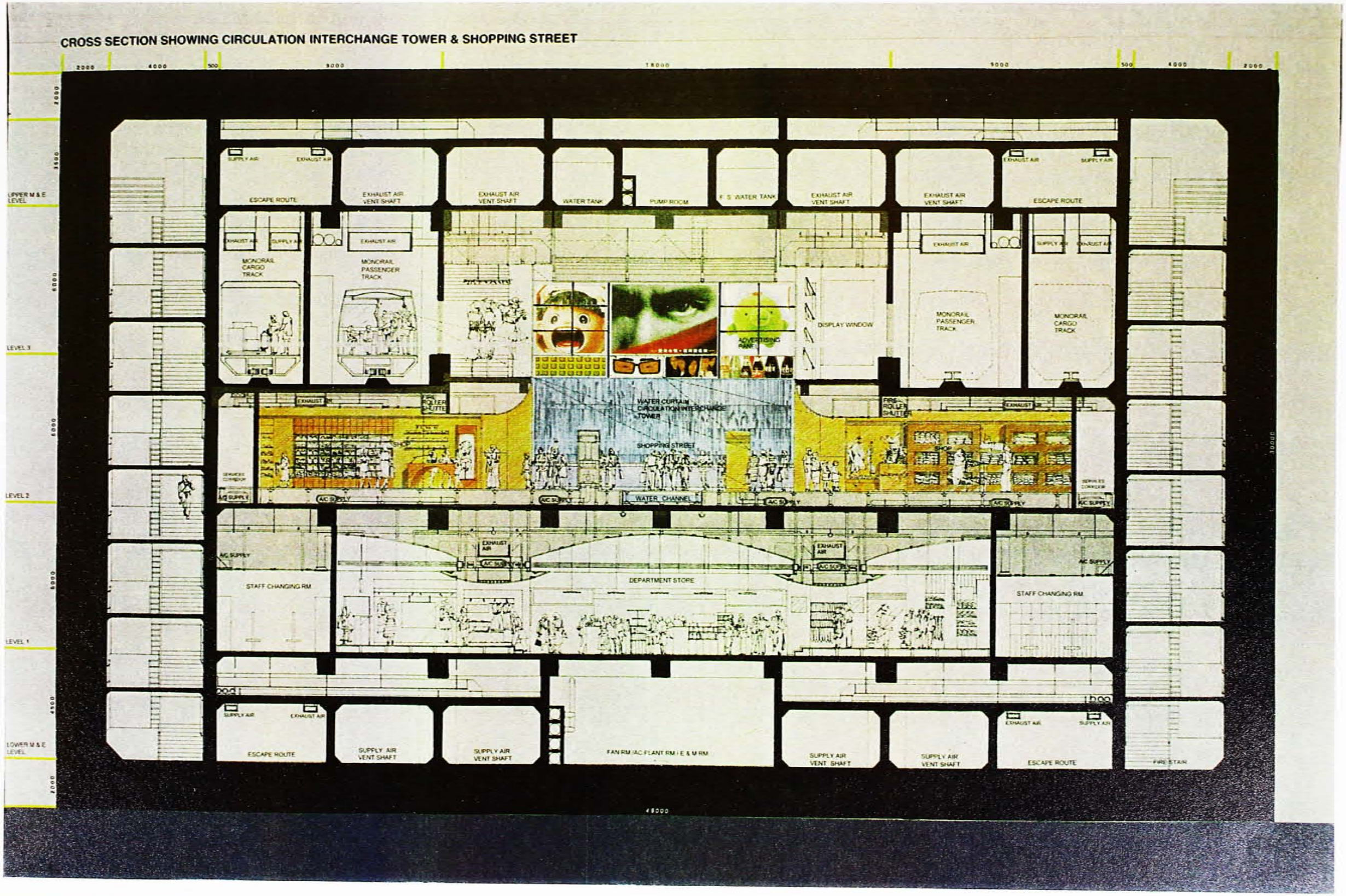
7.4 DETAIL DESIGN



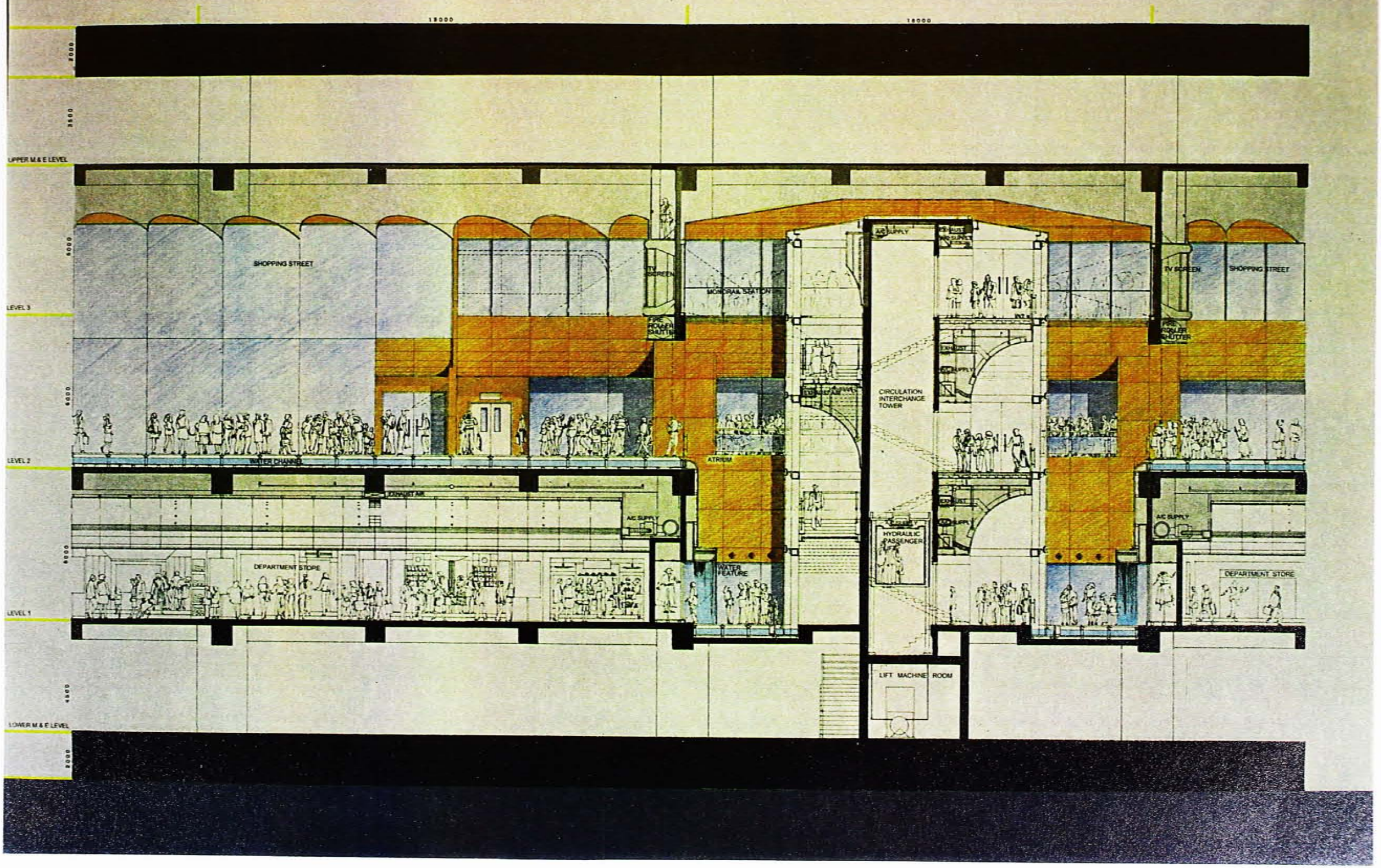
DETAIL PLAN OF CIRCULATION INTERCHANGE TOWER & SHOPPING STREET



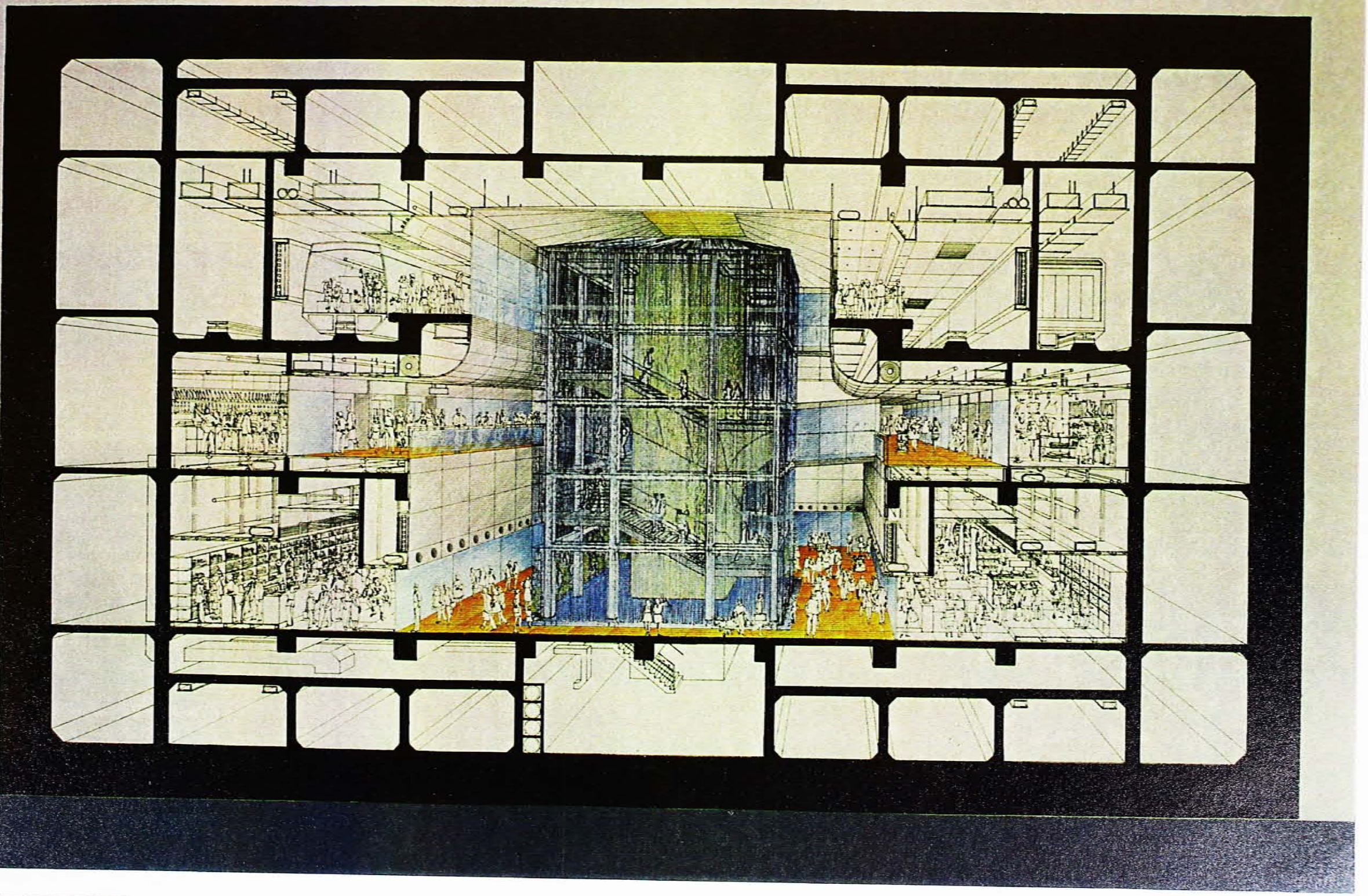
CROSS SECTION SHOWING CIRCULATION INTERCHANGE TOWER & SHOPPING STREET



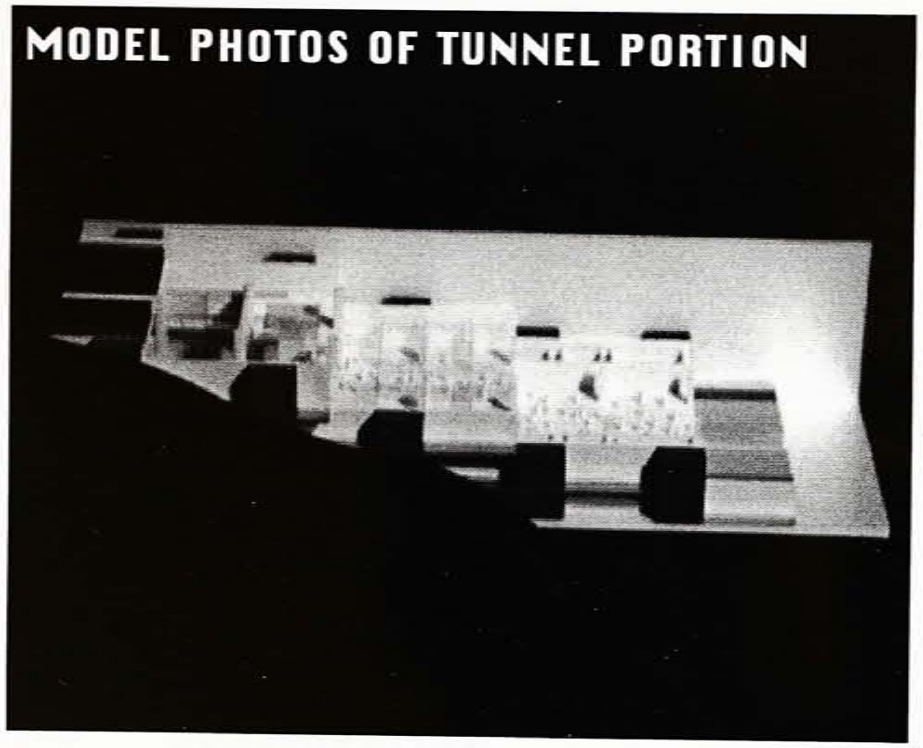
LONGITUDINAL SECTION SHOWING CIRCULATION INTERCHANGE TOWER & SHOPPING STREET

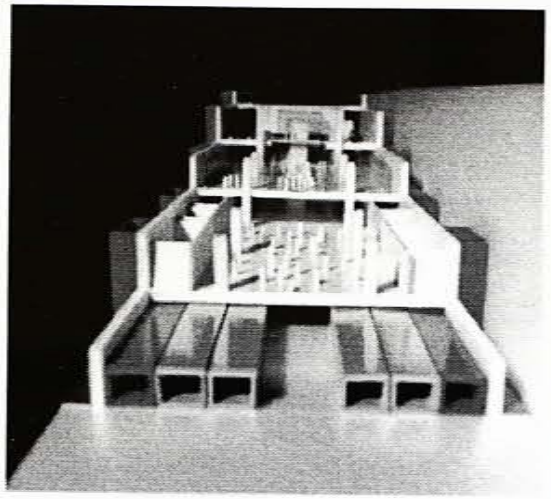


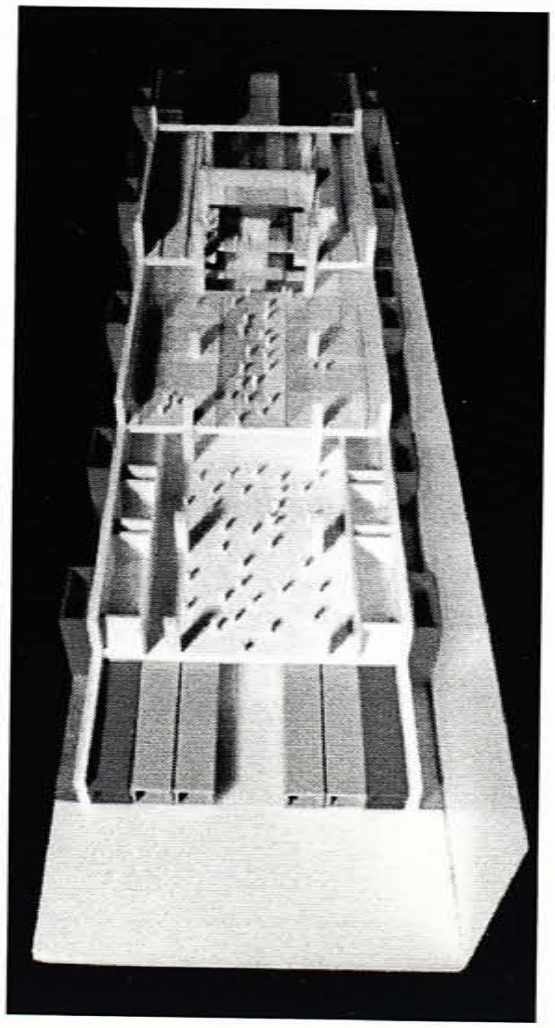
SECTIONAL PERSPECTIVE SHOWING CIRCULATION INTERCHANGE TOWER

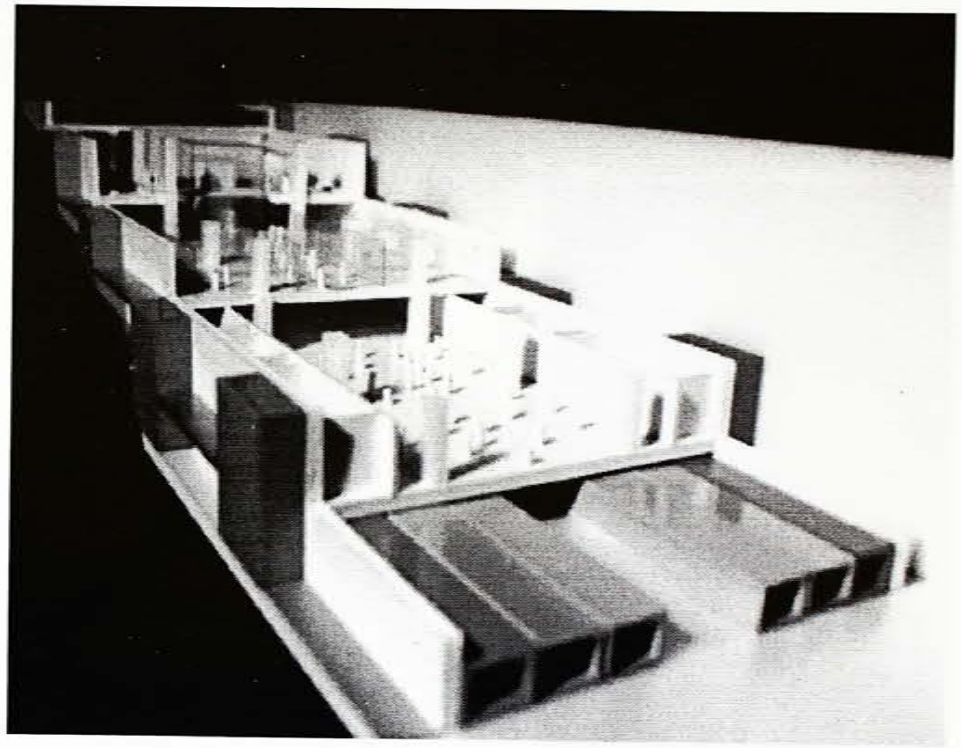


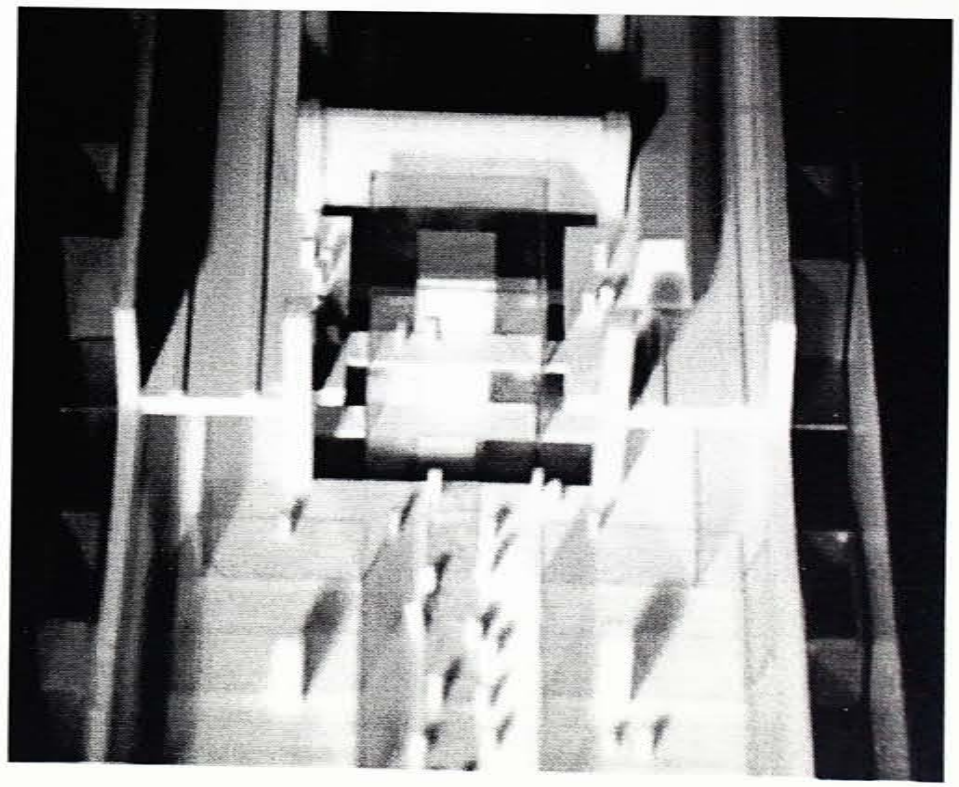
MODEL PHOTOS OF TUNNEL PORTION



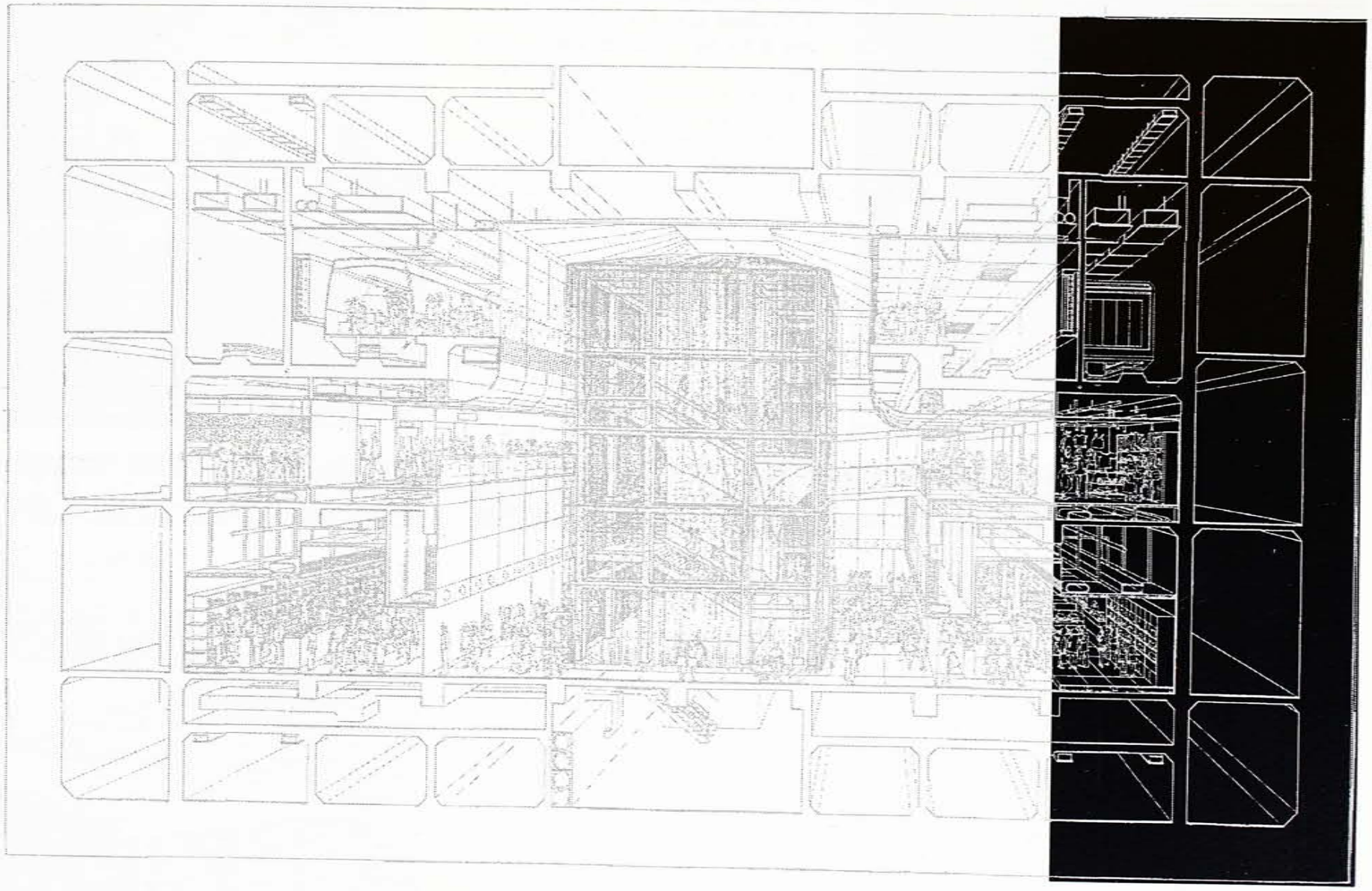








7.5 CONSTRUCTION SEQUENCE



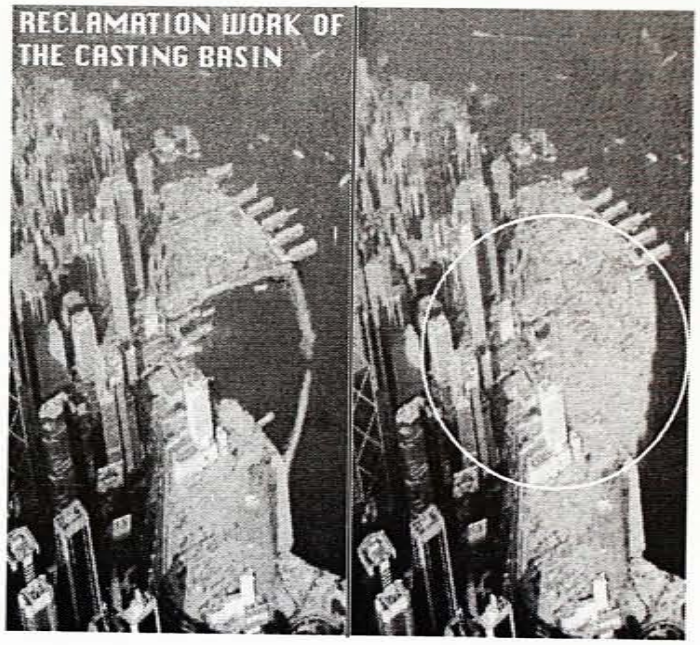
7.51 MARINE WORKS

In total more than 1,500,000 m^3 of material dredge for the 880 m long trench. The base of the trench is approximately 49m wide and 30 m deep with a 1:2 slope produced to the trench sides. Most of the work is carried out using barge mount grabs. The bulk excavation is carried out using 20 m^3 buckets and the trimming of the final surfaces using more delicate 8 m^3 buckets. The order of the work is of paramount importance as it is involved diversions to the main shipping fairway in the harbour and negotiations with the Marine Department of the Hong Kong Government are held on a regular basis.


DIGGING THE SEA TRENCH

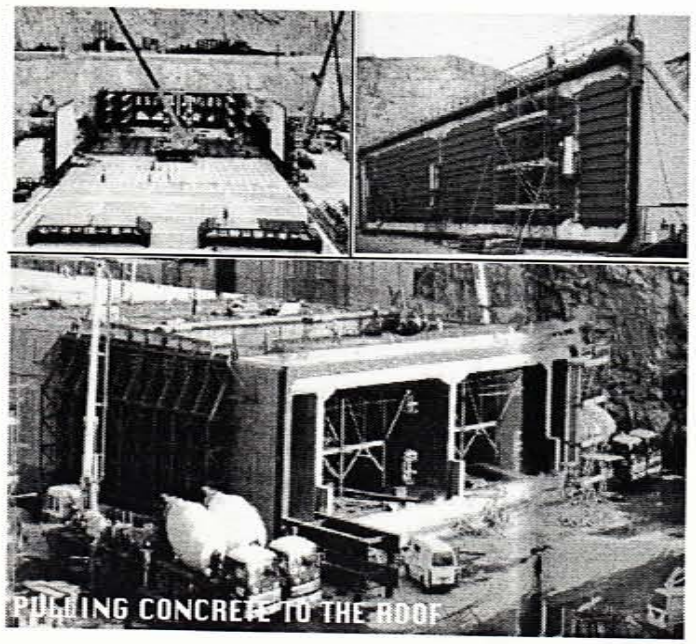
7.52 CONSTRUCTION OF THE CASTING BASIN

The central section of the project comprises an immersed tube tunnel with a total length of 864m. This is made up of 8 pre-cast tunnel sections. The sections will pre-cast in a specially constructed basin at Central Basin on the northern side of Hong Kong Island. The casting basin, hopfully, will become part of the Central-Wan Chai Reclamation Project. A sea cofferdam will construct so as to board the sea water. And then reclamation work will start to the required depth and the whole casting basin is formed. Once the casting basin is finished, the casting of the immersed tube units could commence.


RECLAMATION WORK OF THE CASTING BASIN

7.53 CONSTRUCTION OF IMMERSED TUBE TUNNEL

Each immersed tube unit is 108m x 49m x 30m. They are casted in two batches and each time 4 sections are being casted. Structural steel based formwork is used for this portion of the work. The cantilevered formwork panels are mounted on wheels and could be moved easily along the 108m length of the immersed tube sections. The second lift is concrete for the external and internal walls of the tunnel sections. Structural steel sliding wall forms are erected on the floor of the casting basin. The third lift forms the roof section and complete the tubes.


PULLING CONCRETE TO THE ROOF

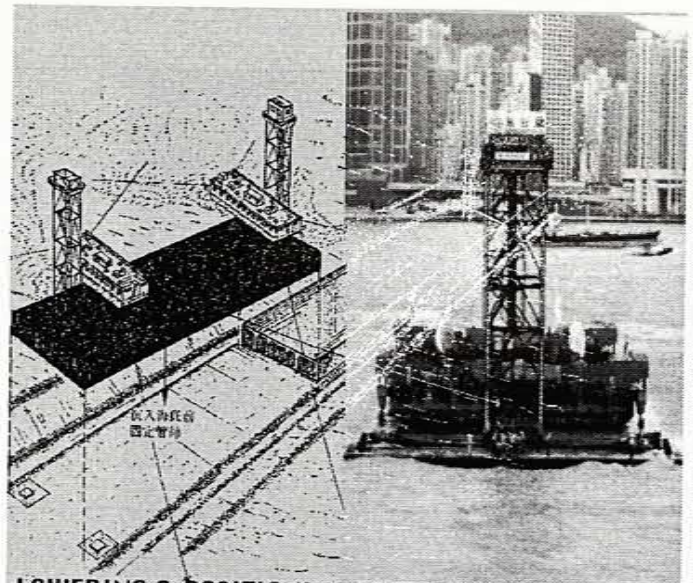
7.54 DELIVERY BY SEA

When construction of the immersed tube tunnel units complete, the internal ballast tanks are filled with water to prevent flotation. The basin is then flooded by pumping in sea water. The temporary cofferdam constructs to allow the exit channel to be formed is then removed by dredger. The ballest water is gradually pumped out so that the units float up and achieve the required freeboard before the units towe to the lowering position. When all the units are removed from the casting basin, it will dewater by pumping and construction of the second batch of units are commenced.


MOVING THE TUNNELS TO THE LOWERING POSITION FROM THE CASTING BASIN

7.55 LOWERING & POSITIONING

All the units, fit with two survey towers, has two winch pontoons site in the roof, attrach by special winch cables. Water is pumped into the internal ballast tanks to make the units negatively buoyant and to transfer the load onto the pontoons. The leading end of the unit engages shear keys projecting from the previous unit and the trailing end is temporarily supported on hydraulic jacks projecting through the tunnel floor and bearing on pre-laid concrete pads. Divers are responsible for monitoring the jacks and ensuring the gaskets are in the correct position and being compressed according to the specification.



LOWERING & POSITIONING OF THE IMMERSED TUBE TUNNEL

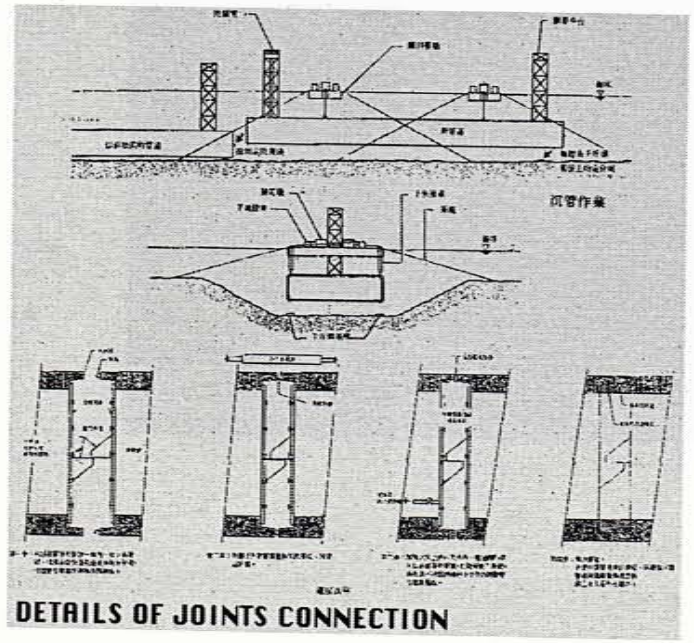
7.56 LOWERING & POSITIONING

Horizontal jacks are linked across the gap between the previous unit and the new unit to draw the units together and make the primary seal of the rubber Gina gasket. The void between the two adjacent bulkheads are dewatered, thereby harnessing on the remote end of the unit to push home and compress the main seal. Dewatering reduces the pressure inside the space between the bulkheads to atmospheric, while the pressure at the remote end of the box is hydrostatic, resulting in the two units being forced together. Sand is pumped and casted into the void under the unit to fill it.

IMMERSED TUBE TUNNEL BEING TRANSPORTED TO THE LOWERING POSITION

7.57 CONNECT TOGETHER

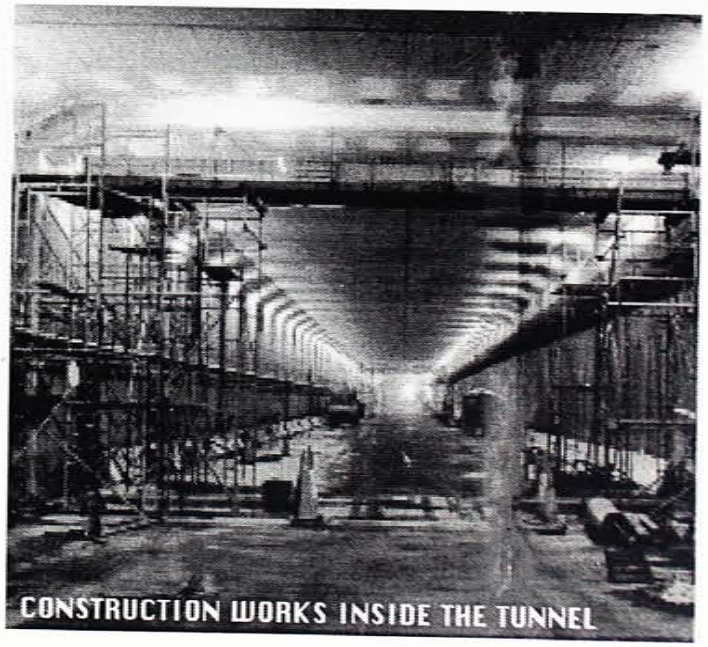
Within the tunnel, the sectional ballast tanks are removed in stages commensurate with placement of permanent ballast concrete. Bulkheads are removed and a permanent secondary seal comprising secondary Omega seals are inserted and sequential works proceeded. Once the units are in position and the sand placing is complete, selected locking fill, comprising a pure sand mix, is pumped around the lower edges of the walls of the immersed tube units. Above the general fill a rock blanket is placed and armoured rock Anchor Release Band is positioned either side of the tube units.



DETAILS OF JOINTS CONNECTION

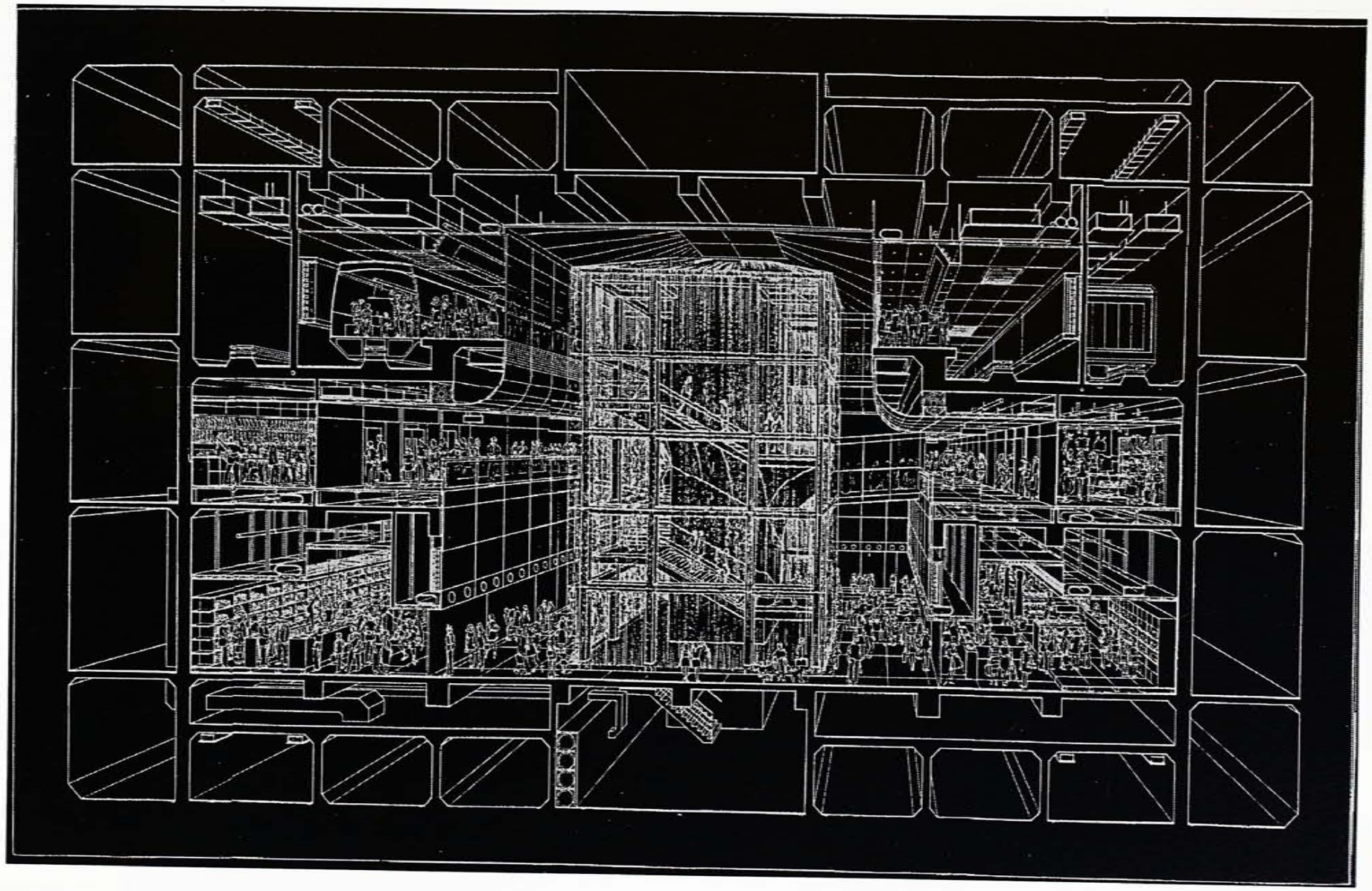
7.58 CONSTRUCTION WORKS INSIDE THE TUNNEL

After complete the construction and installation works of the tunnel superstructure, other construction works include building services like air ventilation, power supply, fire services and etc will start inside the tunnel. At the same time, building works in different section will also start especially the monorail system. It's because the monorail system will transport the majority of construction materials to each section throughout the construction period.



CONSTRUCTION WORKS INSIDE THE TUNNEL

7.6 FIRE SERVICES



FIRE SERVICES

Means of escape

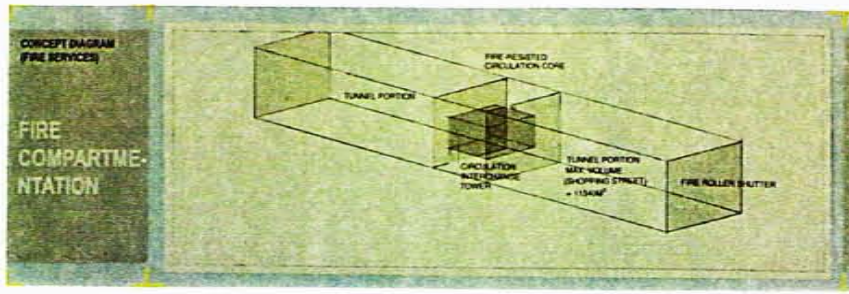
In case of fire or other hazards happen inside the tunnel, there are two ways for means of escape. One is by means of fire stairs and escape routes. Fire stairs are located in each section and all fire stairs are connected to the escape routes. There are totally 4 escape routes with 5m in width. They are located at the four corners of the tunnel. The second method is the monorail system. All monorail stations and the stairs connecting to stations are fire proved. In case of fire or other accidents, monorail will be an effective way to bring people out from the accidential areas.

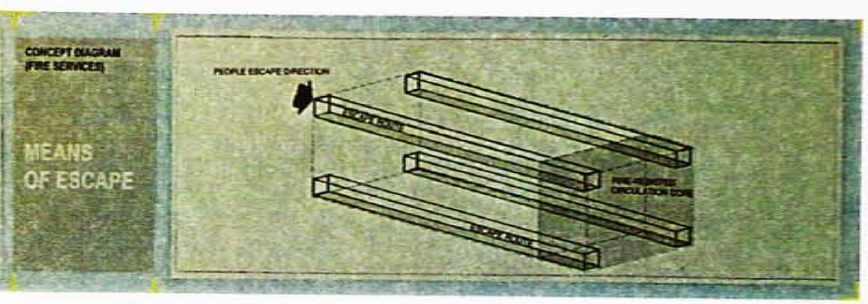
Firemen access

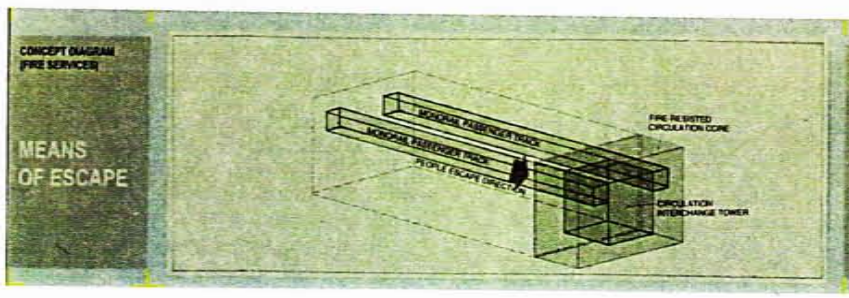
Firemen can enter into the tunnel by the monorail using the cargo track in case of any accidents. Normal cargo loading and unloading works will stop and the cargo track will serve as firemen access route. Besides, all injuries will use the cargo monorail to bring out from the tunnel.

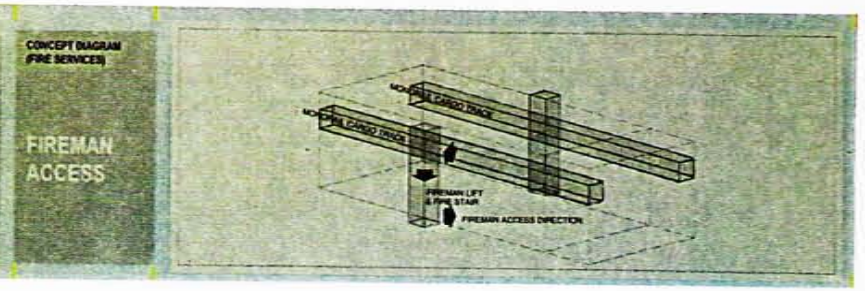
Smoke control and fire fighting

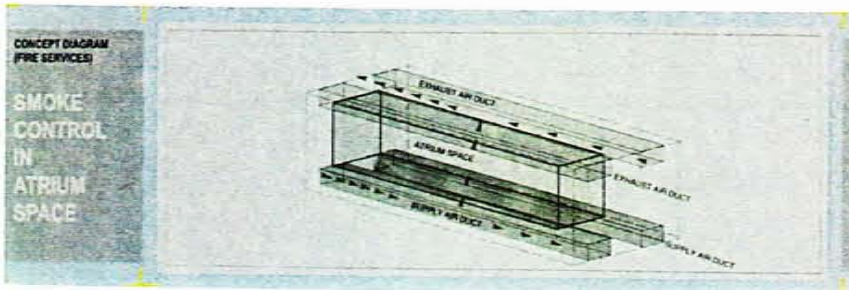
In atrium space, smoke control is created by smoke reservoir, smoke extract system, smoke curtain and fire roller shutter. Smoke reservoirs help to keep the smoke at the beginning of fire accident occur. Smoke extract system is connected between the atrium space and the exhaust vent shaft. The system will extract most of the smoke by high speed fan jets to the exhaust vent shaft so that the smoke will not spread to other space. In large atrium space, fire roller shutters are commonly used to compartmentise different spaces. The biggest compartmentation space inside the tunnel is the shopping street atrium which is not larger than 20,000m³. Furthermore, smoke curtains are used to control the spread direction of the smoke. In small individual space like shops, restaurant, sprinkler system is used for fire fighting.

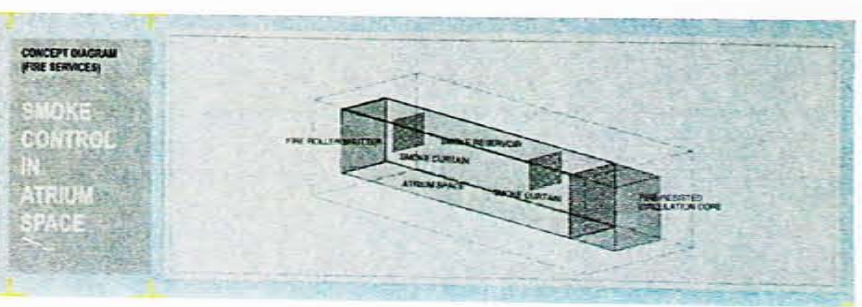


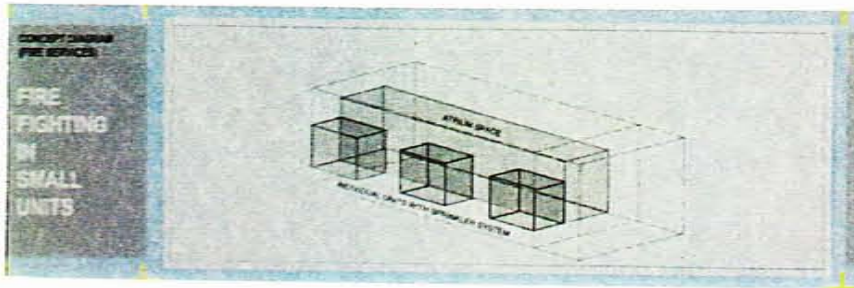


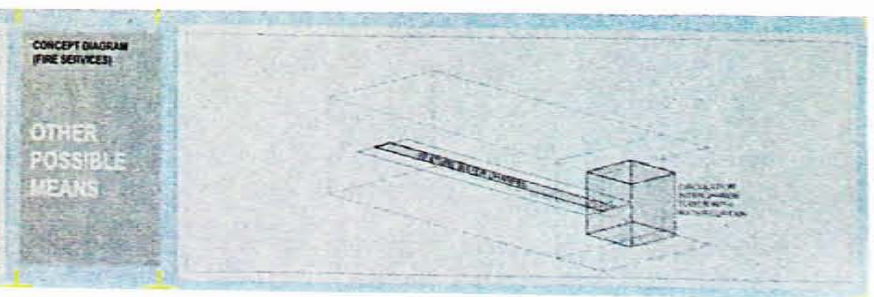




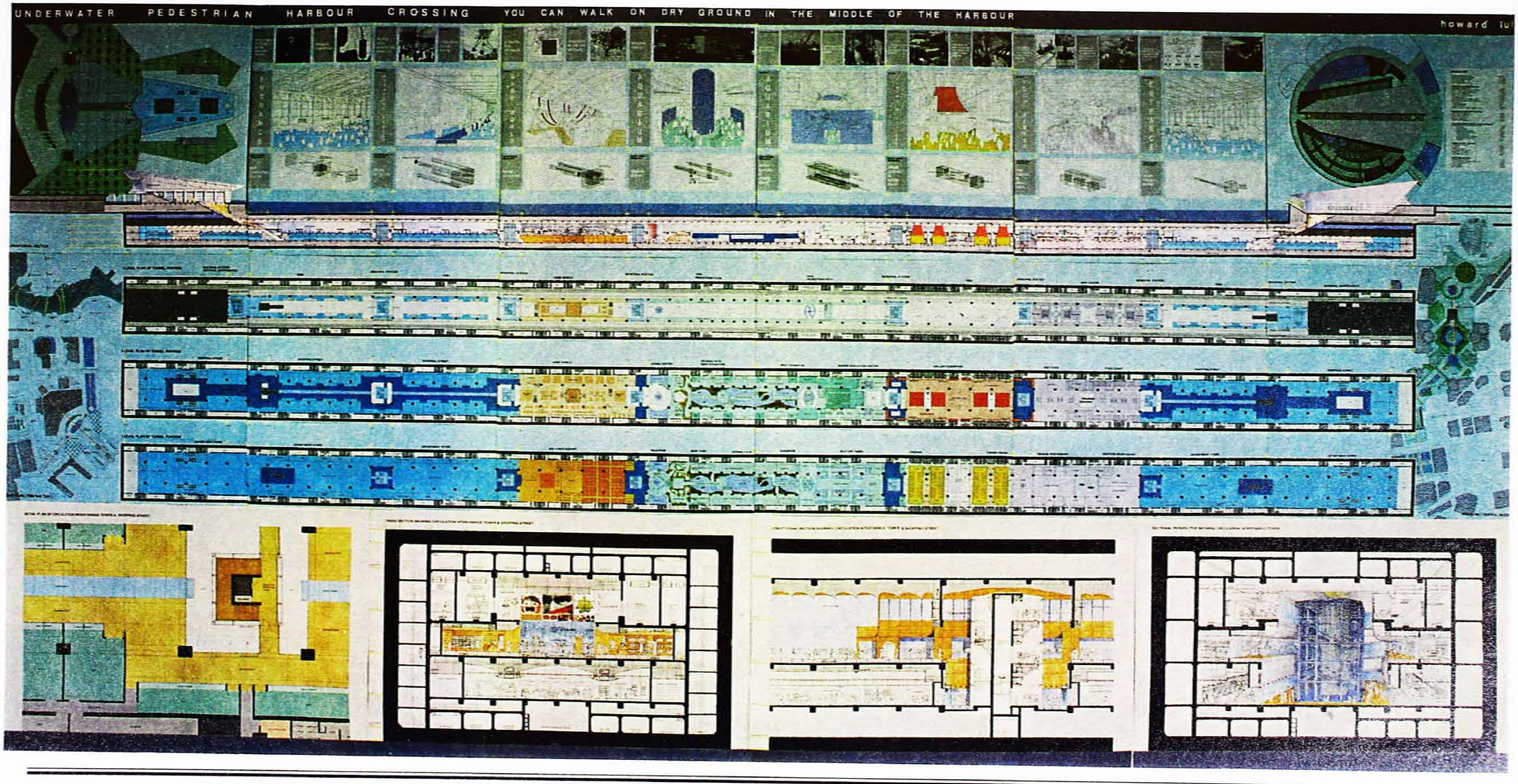








FINAL PRESENTATION



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